VOLUME XXII APRIL 1929 NUMBER 4

Southern Medical Journal

Journal of the Southern Medical Association

Published monthly by the Southern Medical Association, Empire Building, Birmingham, Ala. Annual subscription $4.00. Entered as Second-Class Matter at the Post Office at Birmingham, Ala., under Act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in Sec. 1103, Act of Oct. 3, 1917, authorized Dec. 20, 1921.

SOUTHERN MEDICAL ASSOCIATION, Twenty-Third Annual Meeting, Miami, Florida, November 20-22, 1929. Pre-Meeting Clinics, November 19, 1929

TABLE OF CONTENTS

Influence of Pyogenic and Tuberculous Infections upon Epiphyseal Activity and Growth of Bone. Albertus Cotton, Baltimore, Md. 303

Discussed by C. L. Hall, Washington, D. C.; Bernard H. Kyle, Lynchburg, Va.; O. L. Miller, Gastonia, N. C.; Wm. S. Baer, Baltimore, Md.

A Report of the Study of 25,048 School Children for Tuberculosis. P. P. McCain, Sanatorium, N. C. 310

Discussed by Horton Casparis, Nashville, Tenn.; Arthur G. Jacobs, Memphis, Tenn.; John A. Foote, Washington, D. C.; Lawrence T. Royster, University, Va.

Significance of Internal Pelvimetry and the Application of the Obstetric Inclinometer. J. Bay Jacobs, Washington, D. C. 321

Discussed by Asa B. Davis, New York, N. Y.; M. Pierce Rucker, Richmond, Va.; John Watkins, Asheville, N. C.

Post-Operative Massive Atelectasis. D. C. Elkin, Atlanta, Ga. 329

Discussed by J. M. T. Finney, Jr., Baltimore, Md.; Howard E. Ashbury, Baltimore, Md.

Carbuncle of the Kidney. Thomas D. Moore, Memphis, Tenn 338

Discussed by William A. Frontz, Baltimore, Md.; Robert W. McKay, Charlotte, N. C.; E. Clay Shaw, Miami, Fla.; David M. Davis, Baltimore, Md.; Marion H. Wyman, Columbia, S. C.; T. M. Davis, Greenville, S. C.; R. A. Hennessey, Memphis, Tenn.; A. Mattes, New Orleans, La.

A Modified Technic for Staining the Intercalated Discs of Heart Muscle. J. Edwin Wood, Jr., and Robert L. King, University, Va. 345

Discussed by Ernest W. Goodpasture, Nashville, Tenn.; Harry T. Marshall, University, Va.; Alfred Blumberg, Oteen, N. C.

Diverticula of the Duodenum. C. H. Heacock, Memphis, Tenn. 348

Discussed by D. B. Harding, Lexington, Ky.

(Continued on next page)

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TABLE OF CONTENTS—Concluded

Chorea: A Consideration of its Various Forms. Beverley R. Tucker, Richmond, Va. 351
Discussed by H. Mason Smith, Tampa, Fla.

An Improved Diagnostic Needle and Antrum Punch. G. M. Maxwell, Roanoke, Va. 353

Prophylaxis of Respiratory Diseases with Vaccines. James M. Adams, Baton Rouge, La. 354

SYMPOSIUM ON MALARIA

The Control of Malaria as a Part of Full-Time County Health Department Program. Felix J. Underwood, Jackson, Miss. 357

A Resume of Studies upon Plasmochin. William Krauss, Memphis, Tenn. 359
Discussed by I. J. Kligler, New York, N. Y.; R. L. Miller, Waynesboro, Ga.; M. A. Barber, Greenwood, Miss.

Sodium Cacodylate in the Treatment of Pernicious Malaria. E. E. Murphey, Augusta, Ga. 363
Discussed by J. B. McElroy, Memphis, Tenn.; S. Chaille Jamison, New Orleans, La.; R. L. Miller, Waynesboro, Ga.; William Krauss, Memphis, Tenn.; J. S. McLester, Birmingham, Ala.; V. P. Sydenstricker, Augusta, Ga.; Cabot Lull, Birmingham, Ala.; M. L. Graves, Houston, Tex.

Differences in the Habits of Anophelines Which Transmit Malaria in America, in Europe and in the Far East. L. W. Hackett, New York, N. Y. 367
Discussed by I. J. Kligler, New York, N. Y.

Recent Progress in Malaria Eradication. Frederick L. Hoffman, Wellesley Hills, Mass. 371
Discussed by L. L. Williams, Jr., Richmond, Virginia.

A New Method for Mechanical Distribution of Paris Green as an Anopheline Larvicide: Preliminary Report. J. A. LePrince and H. A. Johnson, Memphis, Tenn. 372
Discussed by Felix J. Underwood, Jackson, Miss.; H. A. Johnson, Memphis, Tenn.

The Mississippi Law and Program for Salt Marsh Mosquito Control. T. H. D. Griffitts, Biloxi, Miss. 374
Discussed by John H. Hamilton, Wilmington, N. C.; L. L. Williams, Jr., Richmond, Va.; C. W. Garrison, Little Rock, Ark.; Felix J. Underwood, Jackson, Miss.

Prevalence of Malaria in Humphreys and Sunflower Counties, Mississippi, in 1927-1928. Paul S. Carley, Belzoni, Miss., and Marshall C. Balfour, New York, N. Y. 377
Discussed by M. A. Barber, Greenwood, Miss.; M. C. Balfour, New York, N. Y.; L. W. Hackett, Rome, Italy; Henry E. Meleney, Nashville, Tenn.

Observations on the Malaria Problem of West Tennessee. Henry E. Meleney, and Eugene L. Bishop, Nashville, Tenn., and Frank L. Roberts, Trenton, Tenn. 382
Discussed by Paul S. Carley, Belzoni, Miss.; M. A. Barber, Greenwood, Miss.

Mosquito Control in Lake County, Tennessee: A County-Wide Screening Program. H. R. Fullerton, Nashville, Tenn. 395
Discussed by L. L. Williams, Jr., Richmond, Va.; Henry E. Meleney, Nashville, Tenn.

Oil Mixtures and Oil Equipment for Anopheline Larvae Control of Impounded Areas. L. M. Clarkson, Atlanta, Ga. 397

Practical Application for Paris Green as a Larvicide for Anopheles Larvae on an Impounded Lake in Alabama. D. G. Gill and C. C. Kiker, Montgomery, Ala., and L. C. Sims, Birmingham, Ala. 399

Malaria Control Activities in Arkansas, 1927-1928. M. Z. Bair, Little Rock, Ark. 404

Malaria in Florida, 1928. E. L. Filby, Jacksonville, Fla. 405

Malaria Control in Georgia for the Year 1928. T. F. Abercrombie, Atlanta, Ga. 405

Malaria Work in Kentucky, 1928. A. T. McCormack, Louisville, Ky. 405

Malaria Work in Louisiana, 1928. Oscar Dowling, New Orleans, La. 406

Malaria Control Operations in the State of Mississippi During 1928. Felix J. Underwood, Jackson, Miss. 406

Malaria Work in Missouri, 1928. W. S. Petty, Caruthersville, Mo. 408

Malaria Activities in North Carolina. Chas. O'H. Laughinghouse, Raleigh, N. C. 408

Malaria Report for South Carolina, 1928. R. G. Hamilton, Columbia, S. C. 410

Progress Report of Malaria Control in Tennessee in 1928. E. L. Bishop, Nashville, Tenn. 410

Malaria Control in Virginia. H. G. Grant, Richmond, Va. 411

EDITORIALS 412
Effects of Artificial Ripening and Bleaching of Vegetables and Fruits
Malaria in the Last Two Years
Liver Extracts in Pernicious Anemia

MIAMI—WHERE ME WEET 415
Big Game Fishing

BOOK REVIEWS 34

SOUTHERN MEDICAL NEWS 36

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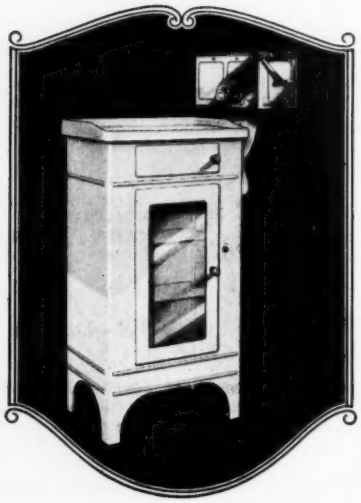

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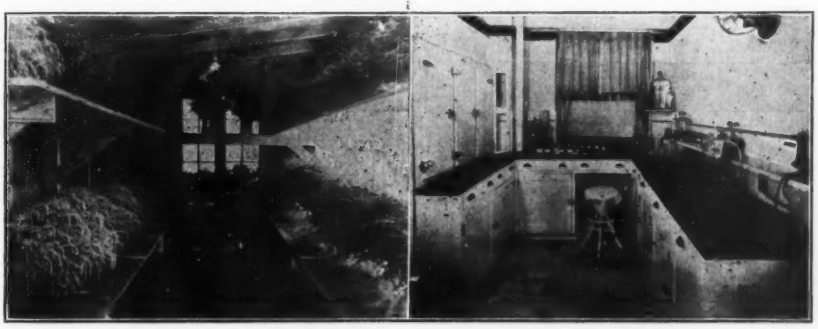

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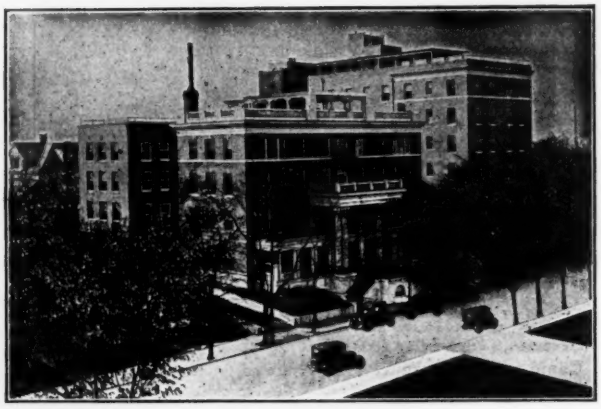

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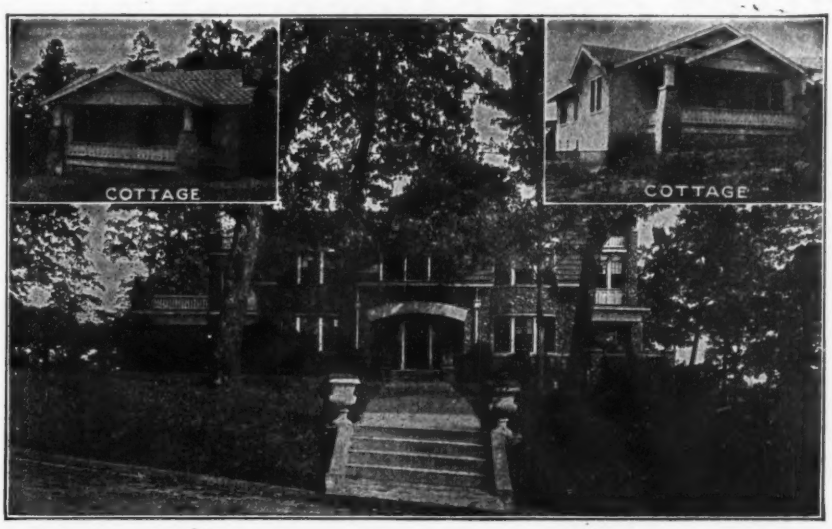

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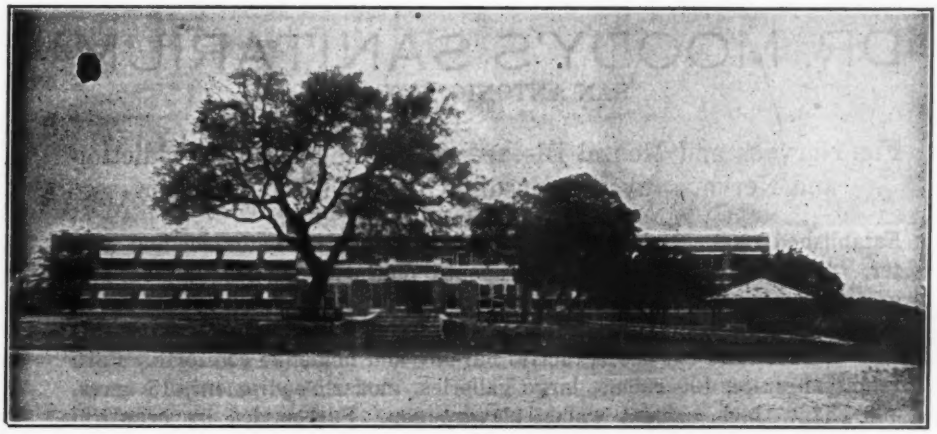

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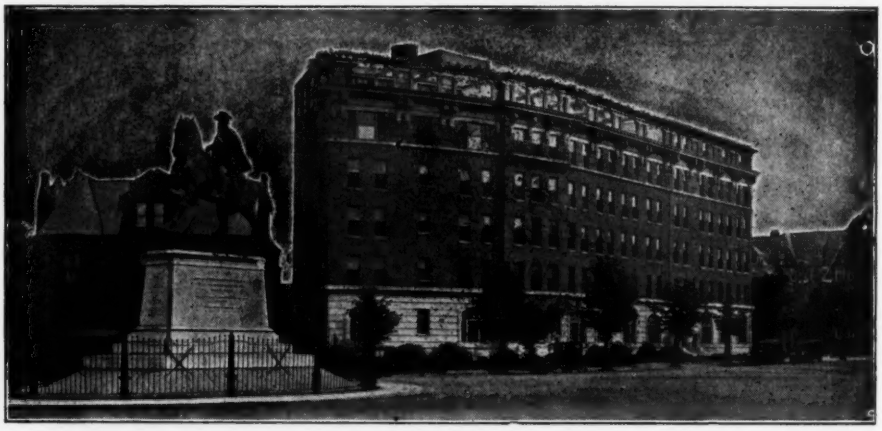

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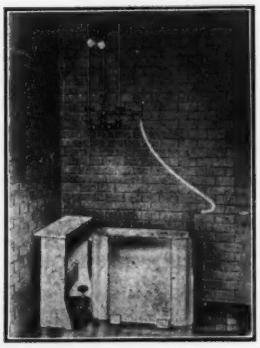

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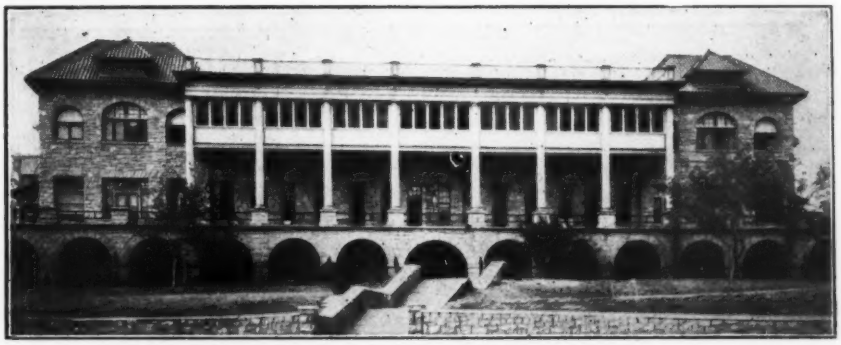

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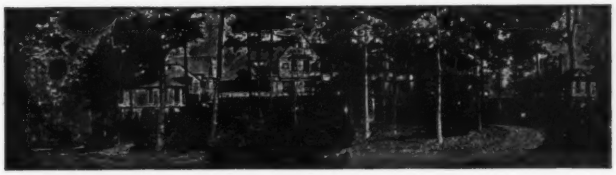

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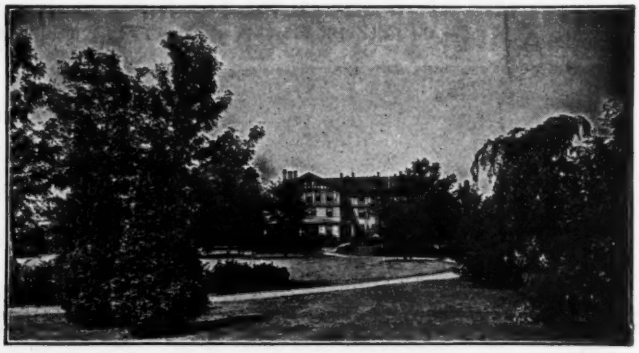

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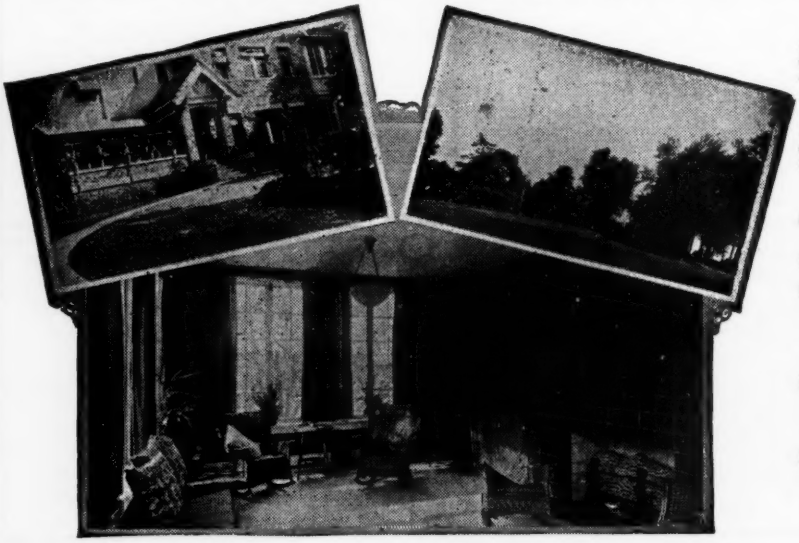

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PUBLISHED MONTHLY BY THE SOUTHERN MEDICAL ASSOCIATION AT BIRMINGHAM, ALA.

Volume XXII APRIL 1929 Number 4

INFLUENCE OF PYOGENIC AND TUBERCULOUS INFECTIONS UPON EPIPHYSEAL ACTIVITY AND GROWTH OF BONE*

By ALBERTUS COTTON, M.D.,
Baltimore, Md.

During the past year in my service at Kernan's Hospital for Crippled Children there were four cases of osteomyelitis of the long bones and two cases of tuberculosis of the knee in which definite lengthening of extremities was noted. These observations induced me to investigate the subject of epiphyseal activity and the effect of disease and injury upon growth of bone.

Increase in circumference of bone (expansion) is accomplished by deposition of new bone from the inner layer of the periosteum. Lengthening of the shaft is due to new bone formation at the epiphyseal cartilage. That growth in length depends upon the activity of the epiphyseal cartilage has been shown by placing metal pegs in the diaphysis and the epiphysis in young growing animals and watching the pegs move apart.

Either one or both of these processes may be altered, increased or decreased by injury or disease. In osteogenesis inperfecta and osteomalacia there are disturbances of the normal development or structure of the shaft (circumference of bone) which causes thinning of cortex, atrophy and softening, with resulting fracture or bowing. Achondroplasia is associated with changes in both shaft and epiphysis; thickening and irregular contour come from excessive periosteal bone formation and partial or complete obliteration of the medullary cavity; enlarged epiphyses with shortening from early sclerosis of the epiphyseal cartilage. Rickets causes characteristic changes in the epiphyseal cartilage and diaphyseal ends and a spongy condition of the shaft, which pathological changes are responsible for the clinical signs of enlarged epiphyses and bowed bones. Syphilis may cause an increase in size (circumference) of bone from productive periosteal bone formation or deformity and stunted growth in length from epiphysitis. Epiphyseal separation and traumatism do not often effect growth in length of bone. This is probably due to the fact that most of the epiphyseal separations are properly reduced and splinted until repair takes place. If an epiphysis is completely separated and not replaced arrested growth of bone will occur at that epiphysis. Probably the best illustration of this fact is the separation of the epiphysis of the external condyle and capitellum of the humerus in the oblique fracture of the external condyle extending into the elbow joint. The separated fragment is frequently completely displaced outward and rotated so that reduction by the closed method is impossible. When the fracture is not reduced by open operation growth of the outer condyle is checked with resulting cubitus valgus deformity.

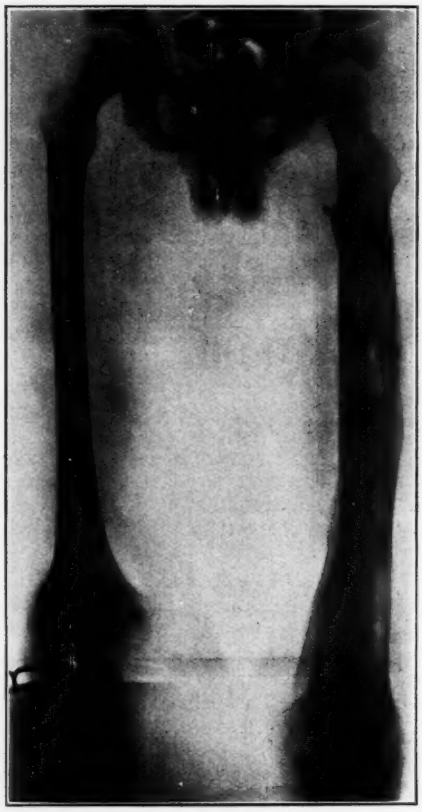
Osteomyelitis usually produces an enlargement of bone and may cause either lengthening or shortening by its effect upon the epiphyseal cartilage. Tuberculosis, epiphysitis or metaphysitis of any of the large joints, but especially of the hip and knee, may be associated at some time in the course of the disease with lengthening of the limb due to increased epiphyseal activity. The end result, however, is usually shortening due to partial destruction or injury to the epiphysis.

The ends of long bones are spongy and have a very thin cortex. There are many perforating vessels present, making this area a very vascular field. The circulation is very sluggish because of the large size of the capillary loops. The epiphyseal cartilage, an avascular structure, lies in the center of this vascular area separating epiphysis from diaphysis. This fact is of great practical importance because it often prevents joint complications in diaphyseal infections. In tuberculosis and

*Read in Section on Bone and Joint Surgery, Southern Medical Association, Twenty-Second Annual Meeting, Asheville, North Carolina, November 12-15, 1928.

osteomyelitis compact bone rarely suffers primarily. New tissue is more susceptible to infection than old tissue and disease processes usually begin near the epiphyseal lines where new bone is being formed. This is the "zone of election of pathological processes" as termed by Ollier. The epiphyseal plate is an extremely resistant structure, and when infection does occur in the end of the long bone, it is to one side of this plate. Pyogenic infections usually begin in the metaphysis, while tuberculosis begins in the epiphysis, although the processes may be reversed.

Diffuse osteomyelitis is associated with the greatest change in bone expansion. To understand this phenomenon, it is necessary to remember the anatomical blood supply of the long bones as revealed by the work of Lexer some twenty years ago and the pathology of hematogenous infection of bone. The long bones receive their blood supply from three sources, which are: the nutrient artery, the metaphyseal arteries, and the vessels of the periosteum. The nutrient artery enters the nutrient canal near the center of the shaft, divides into large branches, which traverse the medullary cavity to each end. The metaphyseal arteries pierce the cortex and supply the medulla of the metaphyseal region. The periosteal arterial supply is in the periosteum surrounding the bone (see Lexer's article).



Case 1. Fig. 1

Case 1, Fig. 2

Case 1, Figs. 1 and 2.—C. G. Chronic diffuse osteomyelitis left femur. Cured. Real lengthening of 1½ inches, compensated for by use of 1½-inch cork sole on right shoe.

Johnson has demonstrated by experiments on dogs that the nutrient arteries supply the medulla and inner half of the cortex. The metaphyseal also supply the medulla and the inner half of the cortex of the metaphysis and to a less extent of the diaphysis. The periosteal vessels supply the outer half of the cortex chiefly, collateral circulation with the medulla being established very slowly. His conclusions derived from this study were that in the repair of bone the nutrient vessels were the most important, the metaphyseal next, and the periosteal the least valuable. He also found that when the central canal was blocked by wax

plugs shutting off the nutrient or metaphyseal arteries, there was abundant periosteal bone formation. Wilensky, in discussing the mechanism of acute osteomyelitis, states that when the main nutrient vessels are plugged by an embolism and thrombus, secondary clotting occurs throughout the entire intra-osseous vascular system, causing maximum disturbance of circulation and necrosis of the entire shaft. A very marked periosteal reaction follows, resulting in the formation of a thick involucrum. This new periosteal bone formation takes place because the periosteal vessels are not injured and the osteoblasts of the periosteum receive a powerful stimulus to activity by the increased blood supply to that membrane. This is the explanation of a well known clinical fact that acute, diffuse osteomyelitis with extensive sequestration is accompanied by a thick involucrum.

Case 3
E. M. Chronic diffuse osteomyelitis left femur. Disease arrested. One inch actual lengthening.

Case 2
D. DeV., age 11. Circumscribed osteomyelitis upper and left tibia. Disease arrested with ¾-inch actual lengthening.

The increased activity of the epiphyseal cartilage resulting in bone lengthening can be explained in the same way, namely: there is increased blood supply to the uninjured arteries of the epiphyseal region due to the inflammation and establishment of a collateral circulation. Decreased epiphyseal activity may be caused by embolus or thrombosis of the metaphyseal vessels in the immediate proximity of the epiphyseal plate or actual destruction of all or a part of the cartilage may occur from the infection with resulting bone shortening.

Sidney Cone, in a report of ossifying hematoma, states that edema, passive congestion and the physical action of a modified circulation as well as the added pabulum of extravasated blood increases the activity of the osteoblasts. Edema softens bone matrix and liberates the bone cell which, together with extravasated blood, attracts lime salts and forms bone. All of the conditions favorable to bone production may be present in osteomyelitis.

Lengthening of the limb in the active stage of tuberculosis of the knee is seen not infrequently. The increased circulation of blood in the region of the epiphyseal cartilage, together with edema and blood extravasation, would seem to be the cause of the increased activity of the

epiphyseal cartilage. Ultimately shortening results. This is chiefly due to destruction of epiphyseal cartilage, partial or complete, together with shortening of the entire limb from atrophy of disuse. In tuberculosis of the hip, lengthening of limb has been noted in the active stage. Epiphyseal activity and distension of the joint from fluid (tubercular) or granulations have been noted in the etiology. Shortening is the ultimate result in practically all cases, due not only to epiphyseal destruction but to disuse, erosion of the acetabulum, shortening of the neck and elevation of the trochanter. Whether or not the lowered vitality often associated with tuberculous joints has any effect upon epiphyseal activity is a question.

Shands, in an analysis of one hundred cases of ossifying patellae, reports that tuberculosis has a definite effect upon the progress of ossification and rickets on the time of appearance of the centers of ossification. The one case reported of delayed ossification was associated with malnutrition.

Baetjer states that malnutrition retards development of centers of ossification. It would seem reasonable to assume that a lowered vitality may have some influence on epiphyseal activity and be partly responsible for the ultimate shortening always found in tuberculous joints. My younger colleague, Dr. Monroe, who has assisted me in the preparation of this paper, believes that the toxins of the tubercle bacillus are non-reactive, and hence we rarely get bone production or ultimate increased epiphyseal activity. In osteomyelitis, on the other hand, we have a reactive toxin produced by the pus organism, which causes bone production and increased epiphyseal activity. He states that this permanent alteration in the length of the bone cannot be accounted for alone by the increased blood supply to the growing end in these conditions, because the final results are different. In seeking another explanation for this fact, at the same time remembering that a characteristic of tuberculous and pyogenic infections in bone is,

Case 4

M. C., age 8 years. Tuberculosis left knee. Duration one year. Actual lengthening of 3/8 inch.

Case 5

T. B. Tuberculosis of the left knee. Duration two years. Measurement shows actual lengthening of 3/8 of an inch.

respectively, bone destruction without new bone formation and bone destruction with new bone formation, we are led to believe that this result in the former is due to a non-reactive toxin, and in the latter to a reactive toxin. In mixed infections of tuberculous joints there is also bone production. Though this belief has no support from the standpoint of animal experimentation, it has strong clinical backing. In tuberculous infection the course is depression throughout. The metabolic rate is decreased and other bodily processes, including epiphyseal activity, are slowed up and real shortening results. If the infection be pyogenic, the course is one of stimulation and activity. The metabolic rate is increased, all bodily functions, including epiphyseal activity, are stepped up, and real lengthening results.

The deformities resulting from lengthening or shortening of the extremities due to alterations of epiphyseal activity are, for the most part, the same as those encountered in tuberculosis of the various joints. A detailed discussion of these problems before this Section of the Association would be superfluous. A mere enumeration of some of the deformities, however, would not be amiss if only to impress you with the importance of the subject.

Case 6. Fig. 1

Case 6. Fig. 2

Case 6, Figs. 1 and 2.—J. A. B. Chronic diffuse osteomyelitis of right femur involving both upper and lower epiphyses. Present condition: small sinus leading to small sequestrum in lower third femur. One inch actual shortening due to epiphyseal injury.

In shortening of one of the lower extremities, the compensating deformities are scoliosis and equinus. With these deformities there may be associated the characteristic deformities of tuberculosis of the hip, knee or ankle. In lengthening there would be scoliosis and possibly equinus on the normal side or abduction of the hip on the affected side to equalize the length of the limbs. Partial destruction of the lower epiphysis of the humerus at the elbow may produce cubitus valgus or varus. Radial or ulnar flexion of the wrist and hand may be produced by epiphyseal alteration, causing lengthening or shortening of one of the bones of the forearm. Varus deformity of the foot due to lengthening of the fibula from osteomyelitis is occasionally seen of such a degree as to necessitate correction by shortening of the diseased fibula. Lengthening of the tibia may also occur, resulting in a valgus deformity of the foot which may require operative correction.

The irregularity in length of the lower extremities due to lengthening of the femur or tibia of one side should be treated conservatively by

the use of a shoe to equalize the length of the limbs. We know that in tuberculous joints the condition corrects or over-corrects itself before the disease runs its course. While no personal observation has been made and no reports have been seen in the literature of the end-results in osteomyelitis bone lengthening, it would seem that Nature would take care of the condition ultimately just as she does the shortening in fractured femur in children.

In conclusion, let me state that the purpose of this paper is to emphasize the fact that many pathological conditions affect the growth of bone both in expansion and length, producing deformities requiring surgical treatment. The most important of these conditions in growing children and adolescents are infectious osteomyelitis and tuberculosis of bones and joints.

Case 1.—C. G., age seven years, at the age of one year had anterior poliomyelitis, which left the left lower extremity almost totally paralyzed. At the age of two and a half years the femur of the paralyzed extremity was the seat of extensive pyogenic (diffuse) osteomyelitis. Primary drainage was done and about one year later operation for removal of sequestrated shaft. The end-result was cure with bone lengthening.

Case 7, Fig. 1
First operation, sequestrectomy. Second operation, plastic to correct valgus deformity.

Case 7, Fig. 2
Valgus deformity before operation.

Mensuration at present reveals a real lengthening of one and a half inches of the involved femur. Compensatory deformities are obviated by the use of an inch and a half cork sole on the shoe of the uninvolved extremity.

Case 2.—D. DeV., age eleven years, at the age of nine years had acute osteomyelitis of the upper end of the left tibia. Preliminary drainage was done, followed by several curettements of the bone cavity. During the course of the illness the patient developed signs of right hip involvement, for which exploratory operation was done. No definite abnormality was found. The operative wound was drained and the patient recovered rapidly. The end-result was cure with ¾ inch lengthening of diseased bone.

Mensuration at present reveals the left tibia fourteen

inches, the right thirteen and one-quarter. He wears a ¾-inch cork sole on the right shoe.

Case 3.—E. M., age nine years, at the age of five years had acute osteomyelitis of the lower end of the left femur. Operation consisted of incision and drainage and later was followed by curettage of a small circumscribed area of osteomyelitis and sequestromies. The end-result was arrest of disease with one inch bone lengthening.

Mensuration at present: left femur 28¼ inches, right 27¼. She is wearing a ¾-inch elevation of the sole of the shoe of the uninvolved right extremity.

Case 4.—M. C., age eight years, at the age of seven years developed tuberculosis of the left knee, which was treated by traction and later by a Thomas knee splint. The duration of the trouble was one year, under treatment in the dispensary.

Measurements on discharge showed the length of the left leg 23¾ inches, the right 23⅜ inches. There was ⅜ inch lengthening of the left leg.

Case 5.—T. B., age three years, at the age of one year fell and injured his left knee, following which injury he developed tuberculosis of the knee. He was treated by traction, followed by application of a cast and later a Thomas knee splint. The duration of the trouble was two years. He had abscess and sinuses.

Case 7, Fig. 3
After operation valgus deformity corrected.

Case 7, Figs. 1, 2 and 3.—S. P., age 8 years. (Patient of Dr. O. L. Miller.) Chronic osteomyelitis left tibia; one inch actual lengthening of tibia after one year's duration, valgus deformity resulting.

Measurements at present show the actual length of the left leg 19⅞ inches, the right 19½. There is ⅜ inch actual lengthening of the left leg.

Case 6.—J. A. B., a white boy, age eight years, had acute diffuse osteomyelitis of the right femur, with *Staphylococcus aureus* infection, March, 1926. Drainage operation, a second operation of drainage and curettage, was in July, 1926. The operative wound healed several months later and the child returned to school. There was recurrence in September, 1928. Operation again consisted of incision and drainage of the abscess. At present there is a sinus leading to the bone cavity and a small sequestrum in the lower third of the femur.

The child did not have a pathological fracture, but there was one inch of actual shortening of the right femur due to epiphyseal injury.

Case 7.—Dr. Oscar Miller's case had diffuse osteomyelitis of the left tibia. Primary drainage operation was done, followed several months later by sequestrectomy. The end-result was arrest of the disease with lengthening tibia and resulting valgus deformity of the foot. This was corrected by plastic operation.

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DISCUSSION (*Abstract*)

Dr. C. L. Hall, Washington, D. C.—I recently had two boys, both five years old, the first one having a proven case of tuberculous disease of the knee joint. After observing him over a period of a year I found there was an actual lengthening of the diseased leg of one-half inch.

The second lad had an osteomyelitis of the lower end of the femur, and the lengthening in six months' time was one inch. The thought occurred to me that the epiphysis apparently causes the lengthening of the leg in proportion. In other words, in the slower tuberculosis of the leg we had less lengthening, while in the osteomyelitis case, our lengthening was very much greater in proportion. This may explain some of the variations in the amount of lengthening in these various legs.

Dr. Bernard H. Kyle, Lynchburg, Va.—Tuberculosis, although a destructive process without bone production, may cause lengthening of the long bones. Is it

because it occurs on the opposite side of the epiphyseal line from that of pyogenic infection which is also a destructive process not followed by bone production? This, of course, is assuming there is no sinus. Dr. Cotton's answer is plausible: that one is a reactive and the other a non-reactive toxin.

It is interesting that growth of long bones continues, unless interrupted by disease until that highly differentiated zone of cartilage undergoes complete ossification.

There are three possibilities for the growth of the diaphysis after the interruption of epiphyseal nourishment: either the metaphysis ceases to grow, or it remains as long as on the normal side, or more intense growth may follow. The latter is the most probable. This increase in length may occur in the metaphysis. The hyperemia, due to degeneration of the epiphysis, must bring more blood to the metaphysis and thus, as in tuberculosis and osteomyelitis, cause an increase in length. On the other hand, a compensatory growth on the opposite end due to elongation of the neck of the femur or coxa valga formation is conceivable. Nonn, after experiments on dogs in which he attempted to, and perhaps did, arrest the nourishment of the lower femoral epiphysis by open operation, concluded that if in the growing individual necrosis of the epiphysis occurs through interruption of food supply the growth of the diaphysis continues, although it is somewhat retarded. During the re-organization of the epiphysis, however, this delay in growth is not only completely compensated, but under favorable circumstances the diaphysis concerned may become longer than that of the sound side after a time. This may be due to collateral hyperemia in the re-organization of the entire epiphysis. Thus, the assumption of a decrease in diaphyseal growth is applicable only for the period of epiphyseal necrosis. The interrupted lengthening of the metaphysis shows further that even when the epiphysis is dead, the line of growth receives sufficient nourishment to maintain life and even by an increase of substance to promote the increase in length of the bone.

Dr. O. L. Miller, Gastonia, N. C.—A few years ago I recognized my first overgrowth of a long bone. I had not read about it in the literature, and thought I was seeing a very new thing. But, a few weeks later, Dr. Speed of Chicago reported a series of cases in his practice, and I found that it was an old entity known to surgery. I have since seen several clinic cases of a low grade type of osteomyelitis, either of the femur or tibia, or both, and have observed overgrowth of from a fraction of an inch up to two inches.

Dr. Wm. S. Baer, Baltimore, Md.—A paper from our Clinic by Dr. Bollman, which is now in press will be out in the near future in the Bollman "Joint Surgery." All efforts of stimulation by means of bacteria, of foreign bodies, organic or inorganic, or of all organic materials have led in the long run to a shortening and not to any increase of bone itself. There may be temporary lengthening for a short while, but the final result is absolute shortening.

Dr. Cotton (closing).—I am uncertain of the ultimate outcome of lengthening bones in osteomyelitis. I have seen no statements in literature. I judge in the end they would correct themselves, but whether or not they would result in actual shortening, as in cases due to tuberculous joints, I am not able to say.

A REPORT OF THE STUDY OF 25,048 SCHOOL CHILDREN FOR TUBERCULOSIS*

By P. P. McCain, M.D.,
Sanatorium, N. C.

Feeling that the study of tuberculosis in children offers one of the greatest opportunities for prevention and cure and also for educating the public concerning the disease, the Extension Department of the North Carolina Sanatorium has devoted a large part of its time during the school sessions of the last two years to a study of tuberculosis among school children.

We work in cooperation with the local health and school authorities. The local authorities do the necessary preliminary work, furnish the nurses, pay for the x-ray films, secure the use of a local x-ray machine and do the necessary follow-up work. The Sanatorium furnishes an expert clinician, provides all necessary literature, charts and forms, makes and interprets the x-ray pictures, correlates the findings and makes recommendations in each individual case.

We study only those children whose parents give written permission and also only those fifteen years of age and under.

When the physician arrives to begin the clinic he first gives the tuberculin test to all the children to be studied. We use the intracutaneous test, 0.1 c. c. of a 1:1000 dilution (0.1 mg.) of Koch's old tuberculin being given to each child. The tests are read by the clinician usually within forty-eight hours and always within seventy-two hours. With proper assistance and cooperation, one clinician can test 250 or more children per school day. In the first 1,200 cases we gave a second dose of 0.1 c. c. of a 1:1000 dilution (1 mg.) to those giving a negative reaction, but we found so few additional reactors, and none of them having clinical disease, that we felt that for practical purposes it was sufficient in clinic work to use only the medium size dose of 0.1 c. c. of 1:1000 dilution (0.1 mg.).

No further study is made of the negative reactors. The positive reactors have a contact and clinical history taken by the nurse and checked over by the clinician; they are given a general physical examination, which includes the chest, by the clinician, and they have postero-anterior and oblique x-ray pictures of their

*Read in Section on Pediatrics, Southern Medical Association, Twenty-Second Annual Meeting, Asheville, North Carolina, November 12-15, 1928.

chests made by the radiological staff of the Sanatorium. The clinician can examine 20 to 25 children per school day.

We use a local x-ray machine, preferably that of a local hospital. In counties where there are no x-ray machines the children are transported in buses either to the Sanatorium or to an x-ray in one of the neighboring counties. In no case, whether the x-ray was privately or publicly owned, has there ever been a charge for the use of the machine. With the help of nurses and teachers to manage the group of children to be x-rayed, the writer and one assistant usually made two exposures on from twenty to twenty-five children per hour. The films are brought to the Sanatorium to be developed and studied and the findings are correlated with the information obtained from the history and physical examination.

We endeavor in every way to make the study a demonstration clinic, hoping that the local authorities and the local medical profession will become permanently interested. Already some of the health officers have conducted follow-up clinics, doing all the work through their own organization except for the making and interpreting the x-ray pictures, this being done by the Sanatorium staff.

During the last two school years we have studied, as above outlined, 25,048 children with the results shown in the following summary.

The study includes children from all conditions of life, white and colored, rich and poor, urban and rural. It is seen that 22.59 per cent of the children tested showed a positive tuberculin reaction. This percentage compares favorably with reports from other sections of the country, and especially with reports from the tests made on children in crowded cities.

One and 79 one hundredths per cent of the total number tested, or 7.62 per cent of the positive reactors, were diagnosed as having demonstrable tuberculosis.

The colored children showed both a higher percentage of tuberculin reactions, 27.41 per cent as compared with 22.07 per cent for the whites and also a higher incidence of demonstrable tuberculosis, 3.21 per cent of the total number tested as compared with 1.53 per cent for the whites.

From the summary it is noted that of those showing a positive tuberculin reaction, 411 were neither examined nor x-rayed. Some had moved away, some were out of school for various other reasons when the clinician came back to make the examinations and some few of the reactors or their parents refused to have the examinations made.

Of the reactors examined 541 were not x-rayed, a small proportion for the same reasons as just outlined. However, the great majority are from a few communities where the available funds for

SUMMARY OF RESULTS OF SCHOOL CHILDREN'S TUBERCULOSIS CLINICS CONDUCTED BY THE EXTENSION DEPARTMENT OF THE NORTH CAROLINA SANATORIUM, IN COOPERATION WITH LOCAL HEALTH AND SCHOOL AUTHORITIES

During School Sessions 1926-27 and 1927-28

Results of Tuberculin Test

	White	Colored	Total
Number given tuberculin test	22,550	2,498	25,048
Number negative reactors	17,574 (77.93%)	1,815 (72.66%)	19,389 (77.41%)
Number positive reactors	4,976 (22.07%)	683 (27.34%)	5,659 (22.59%)

Results of the Study of the 5,659 Positive Tuberculin Reactors

			Per Ct. of the 5,659 Tuberculin Reactors	Per Ct. of the 25,048 Tested
Number reactors for various reasons not examined		411	7.28	1.64
Number examined, though for various reasons not x-rayed, the majority having mild reactions and presumably no demonstrable tuberculosis		541	9.55	2.16
Number having physical examinations and x-rays of chest (postero-anterior and oblique)		4,707		
Number of reactors classified as not tuberculous	3,602		63.64	
Number classified as suspicious	674		11.91	2.69
Number having demonstrable tuberculosis	431		7.62	1.72
White 346 (1.53% of 22,550 tested; 6.95% of 4,976 reactors)				
Colored 85 (3.21% of 2,498 tested; 12.44% of 683 reactors)				
Tracheobronchial	388			
Tracheobronchial and pulmonary (parenchymal)	4			
Pulmonary (parenchymal)	23			
Extrapulmonary	14			
Extrapulmonary and tracheobronchial	2			
Total number classified as definitely not tuberculous		22,991		91.79
Positive tuberculin reactors found not tuberculous	3,602			
Negative tuberculin reactors	19,389			

paying for the x-ray films was so limited that those children who had no suspicious symptoms or family history and who had very mild reactions were not x-rayed because they were considered as probably not tuberculous.

From the summary it is also seen that 674, or 2.69 per cent of the total number tested were classified as suspicious. This group includes those who had either strongly suspicious symptoms without other discoverable cause, or suspicious x-ray findings, or both.

Of those showing demonstrable tuberculosis, 388 were classified as tracheobronchial, 23 as pulmonary (parenchymal), four as tracheobronchial and parenchymal, 14 as extrapulmonary, and two as tracheobronchial and extrapulmonary. The small number, practically 0.1 per cent, having parenchymal lesions, the type usually found in adults, is quite noticeable. It must be kept in mind, however, that this is a group of children supposed to be well enough to go to school. A study of tuberculosis in a group of sick children, such as those who are sent to an institution for treatment, would show a higher percentage, though even in such a group the parenchymal lesion is very rare.

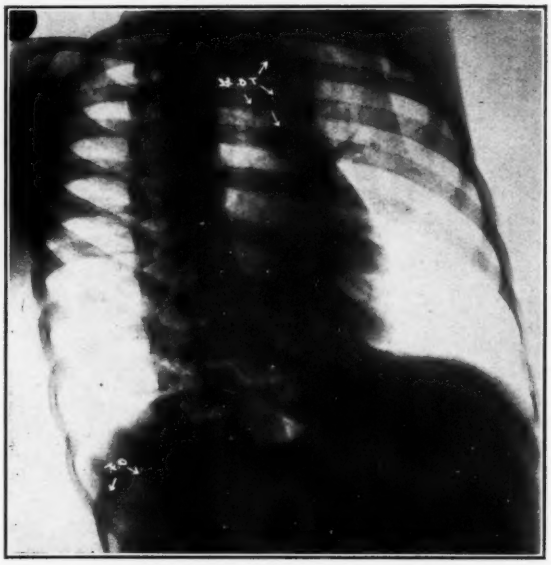

Fig. 1-b (Oblique)

Fig. 1-a and Fig. 1-b. Tracheobronchial tuberculosis showing multiple primary foci (P. F.), seen in both postero-anterior and oblique, and multiple tracheobronchial tuberculous glands (T. B. Gl.), seen better in oblique.

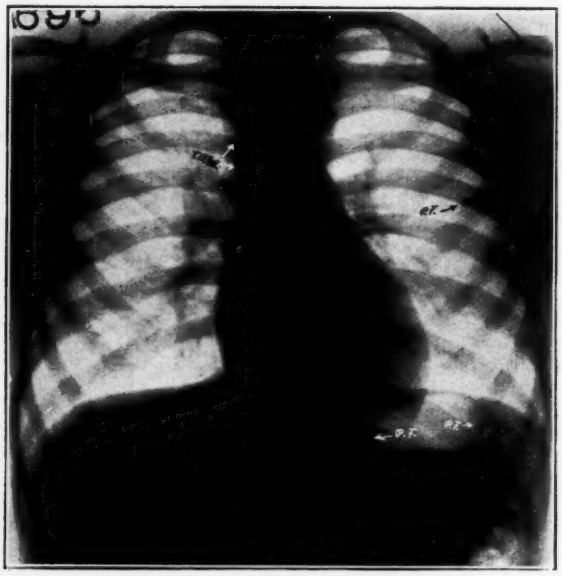

Fig. 1-a (Postero-Anterior)

The very small number of extrapulmonary cases is also worthy of comment and is a testimonial to better sanitation and a purer milk supply in recent years. The most outstanding fact in surveying the 431 positive cases is that 388 were of the tracheobronchial type. Because of the preponderance of this type, because of the difficulty in making an accurate diagnosis in such cases and because of the relative ease in diagnosing other types, I will dwell at some length upon the discussion of tracheobronchial tuberculosis.

PATHOLOGY

This form of the disease, variously termed tracheobronchial, juvenile and hilum tuberculosis, is a primary infection occurring in children whose tissues are non-allergic, or not hypersensitive to the tubercle bacillus. It is the same form that is found in ex-

perimental tuberculosis in animals infected for the first time. Ghon[1] points out that as early as 1876 Parrot called attention to the characteristic pathology of tracheobronchial tuberculosis. The disease is characterized by a primary focus formed largely by a proliferative process located at the periphery of the lung, and by an involvement of the pulmonary and tracheobronchial lymph nodes which drain the area of the primary focus. The pulmonary focus is usually single, though at times there are multiple foci (*Fig. 1*). They vary in size from the smallest tubercle to that of a small hickory nut. Foci are more frequently found in the lower half of the lungs and more frequently on the right side.

Fig. 3-a (Postero-Anterior)

A knowledge of the minute anatomy of the lung and of the pathology of primary tuberculous infections is essential to a full understanding of tracheobronchial or juvenile tuberculosis. The infecting bacilli are almost always carried to the periphery of the lung and infection takes place in the primary lobule, the minute unit of the lung. There is no hypersensitiveness of the tissues to fix or localize the bacilli; so as they multiply they pass out of the original tubercle and are caught up by the lymph channels, whose valves, pointing toward the hilum, force the bacilli to the pulmonary and tracheobronchial lymph nodes. Under favorable circumstances these nodes constitute a sufficient barrier to the further progress of the bacilli to the blood stream, and, hence, prevent a generalized tuberculosis. The bacilli continue to grow and multiply in the lymph nodes, and one of the characteristics of this form of the disease is that the lesion in the lymph nodes is usually more extensive than in the primary focus. The latter is frequently no larger than a small shot or pea, while the lymph glands may be even larger than an almond.

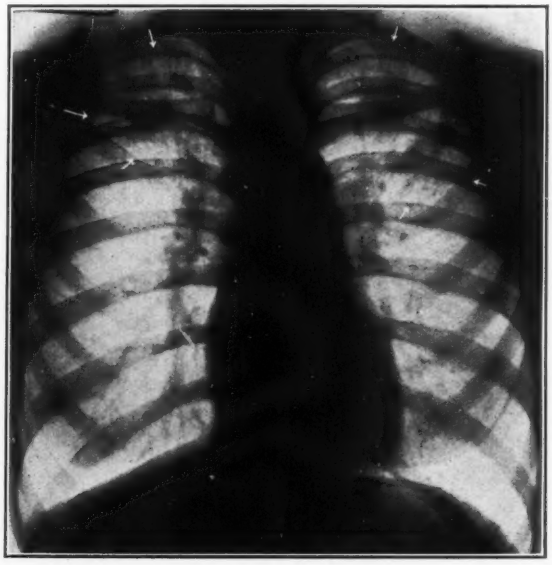

Fig. 2
Parenchymal tuberculosis, a secondary infection, the usual type seen in adults, but rather rare in children.

In contrast to the tracheobronchial is the usual adult apical, or parenchymal form of pulmonary tuberculosis. This represents a secondary infection, an infection occurring in a previously infected individual and consequently in tissues which are hypersensitive or allergic. Infection in this type of the disease also takes place at the periphery of the lung, but there is an exudative, inflammatory, instead

of a proliferative, reaction at the site of the infection (*Fig. 2*). The bacilli are not carried off by the lymph stream, but are localized by the inflammatory process, and the battle is staged in the parenchyma of the lung. For this reason we do not find the regional pulmonary and tracheobronchial lymph nodes involved in the adult or secondary infection type of tuberculosis.

DIAGNOSIS

An understanding of the pathology of tracheobronchial tuberculosis will make it apparent that an accurate diagnosis of the condition will require painstaking care and a correlation of all obtainable information. The diagnosis depends upon

(1) A positive tuberculin test.

(2) Symptoms.

(3) X-ray findings.

(4) General physical and laboratory examinations for the elimination of other causative factors.

The Tuberculin Test.—The first essential for a diagnosis of clinical tuberculosis in a child is a positive tuberculin test. The use of the test should be routine in every suspected case. As Krause[2] says,

"Here lies one of our greatest opportunities in diagnosis today. Those of us who take life and our profession seriously run the danger of despondency in contemplating the time wasted in striving to manufacture consumptives by all the many more or less devious or dubious methods when days and weeks previously a simple skin test or two would have proclaimed that the materials necessary for tuberculosis, to-wit, tubercles, do not exist. This point we might have settled within two or three days of first meeting with our patient, and then gone on to more profitable and productive 'leads' as we dismissed tuberculosis from our minds."

The only two tests which can be recommended for general use are the von Pirquet skin test and the Mantoux, or intracutaneous. Koch's old tuberculin is used for both.

The von Pirquet is somewhat less sensitive, but has the advantage of being much more convenient. The North Carolina Sanatorium furnishes tuberculin for this test without charge in capillary tubes with sterile scarifier and full directions for its use and interpretation to any physician in North Carolina. It will rarely fail to be positive if the infection is sufficiently serious to be of clinical significance.

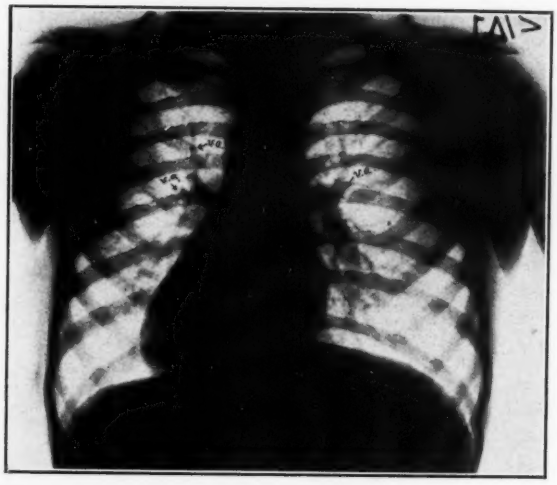

Fig. 4-a (Postero-Anterior)

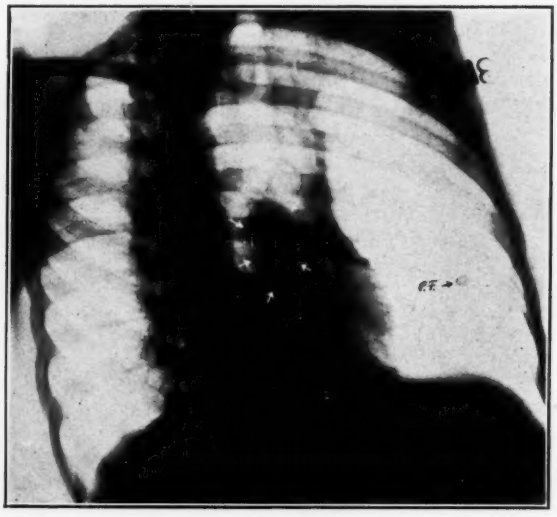

Fig. 3-b (Oblique)

Fig. 3-a and Fig. 3-b. Showing importance of oblique position. A large mass of caseo-calcareous glands (almost as large as a lemon) can be seen in the oblique below the bifurcation of the trachea, only the margin of which can be seen in the postero-anterior. P. F., primary focus; T. B. Gl., tuberculous gland.

The intracutaneous test is used in dilutions of from 1:10,000 to 1:100 in 0.1 c. c. amounts, the dose thus varying from .01 to 1 mg. The dilutions are made with normal salt solution containing 0.25 per cent carbolic acid. As stated above, this test is more sensitive. Burhans[3] states that the von Pirquet is equal in sensitiveness to 0.01 mg. intracutaneously. If the smallest intracutaneous dose is negative, 0.1 mg. and then 1 mg. doses are given at 24-hour or longer intervals. The intracutaneous has the double advantage of being more sensitive and of having a quantitative value. One can measure the degree of reaction and also gain useful information from the quantity of tuberculin necessary to produce the reaction.

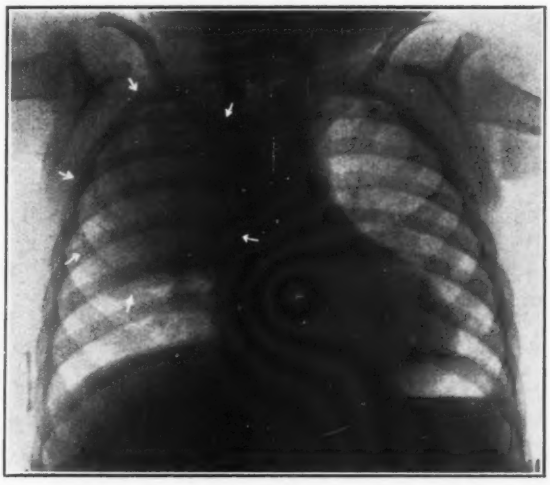

Fig. 5

Tuberculous pneumonia, probably resulting from the rupture of a tuberculous tracheobronchial gland into a bronchus. Age, one year; tuberculin test positive; mother has far advanced tuberculosis.

In a well organized clinic or hospital the intracutaneous method should be used routinely. In general practice the von Pirquet is the most practical for ordinary use, the intracutaneous method being used only in very suspicious cases in which the von Pirquet is still negative after being once or more repeated.

For a period of a few weeks following measles, whooping-cough, influenza and perhaps some other acute diseases, there is supposed to be a suppression of tissue allergy; so that in case the test is negative in such a child, it is necessary to repeat it later before tuberculous infection can be ruled out. In very advanced cases of tuberculosis also the resistance may be so overwhelmed that the test will be negative. These latter will rarely present a difficult problem for diagnosis, however.

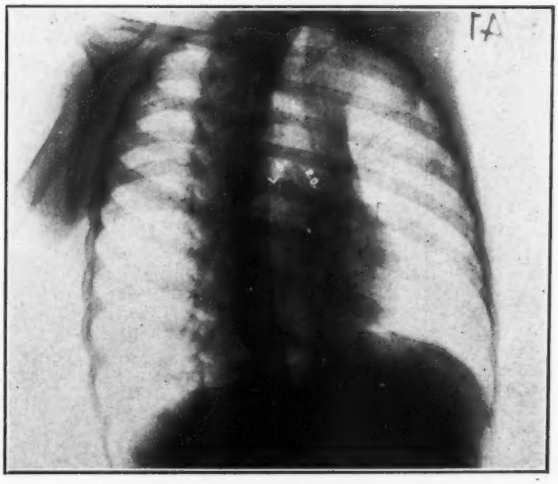

Fig. 4-b (Oblique)

Fig. 4-a and Fig. 4-b. Normal chest. V. A., vascular artefacts due to vessels axially radiated and frequently mistaken for calcified tuberculous glands. No primary focus can be seen and they are not seen in an oblique. T., trachea; R. B., right bronchus; L. B., left bronchus.

A positive tuberculin test only indicates tuberculous infection, the presence of live tubercle bacilli somewhere in the body, Krause[4] having shown that a positive reactor will become negative to the test after the tubercle bacilli die out. If the test is positive, the child may or may not have tuberculosis. If it is negative, there is neither any tuberculosis nor even any tuberculous infection. A negative test is exceedingly valuable information, and in the South especially will be found in the great majority of children tested. As shown above, of 25,048 school children to whom we gave the tuberculin test (0.1 mg. intracutaneously) 5,659, or only 22.59 per cent, gave a positive reaction; 1.72

per cent of the whole number tested, or 7.62 per cent of the positive tuberculin reactors, were found to have demonstrable tuberculosis. Too much emphasis cannot be laid upon the importance of a test which in so large a proportion of cases will settle the diagnosis.

We also feel that the degree of reaction to either form of the tuberculin test is of some value, the stronger reactions being more suggestive of clinical disease. By far the largest number of cases of clinical tuberculosis that we have found have been among those children who have given strong reactions.

Opie and McPhedran[5] say:

"The probability of grave tuberculous infection increases with the severity of the tuberculin reaction."

Krause[6] also states:

"Cutaneous hypersensitiveness varies directly with the extent and intensity of the disease, just as it increases with progressive disease, diminishes with the healing of the disease, and is increased by reinfection."

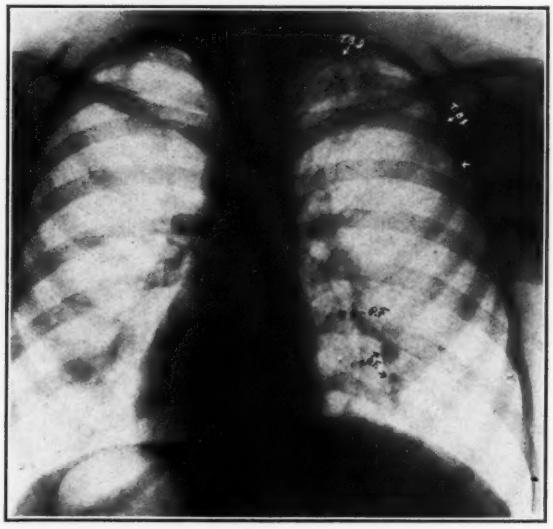

Fig. 7-a (Postero-Anterior)

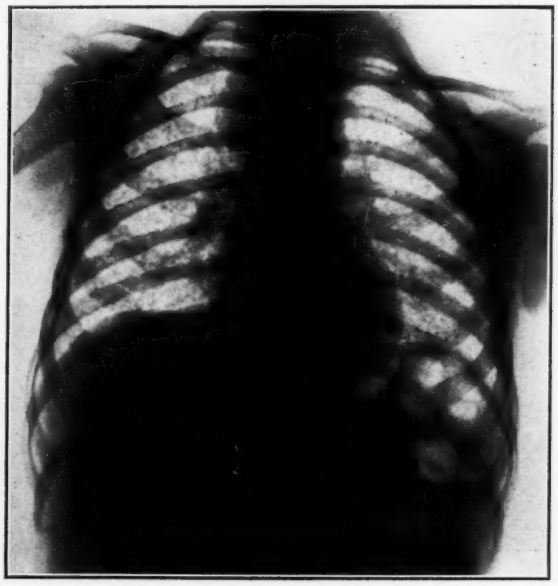

Fig. 6
Miliary tuberculosis, resulting from rupture of a tracheobronchial gland into a blood vessel. Age, 2 years; tuberculin test positive; grandmother has tuberculosis.

Symptoms.—There are no characteristic symptoms of childhood tuberculosis. The following are those more frequently found: undernourishment, an actual loss of weight being rather unusual, but a failure to grow and gain weight being very common; poor appetite: fatigue, or tiring easily; a lack of energy, the child showing a tendency to avoid forms of amusement requiring much exertion; a tendency to nervousness or to be peevish and irritable; a delayed recovery from some other disease, such as measles, whooping-cough or influenza, without any other complications to explain the delay.

Fever is usually present, though it is not so uniformly of the subnormal morning and elevated afternoon or evening type as in the adult form of the disease. Fever is also of less significance as a diagnostic sign because it is usually of the mild degree which is so commonly caused by other conditions in childhood. The pulse is likely to be accelerated. There may be a tendency to frequent colds. If a cough is present it is nearly always non-productive. Dyspnea is rarely present, being found only in those cases in which the glands are large

enough to exert pressure on the trachea or bronchial tree.

As stated above, the symptoms found in childhood tuberculosis are not pathognomonic, but may be caused by a number of other conditions, as diseased tonsils and adenoids, sinusitis, hookworm disease, pyelitis, or cardiac disease. It is also true that not infrequently cases of tracheobronchial tuberculosis demonstrable by the x-ray have no symptoms causing the patient to feel sick.

Physical and Laboratory Examinations.—The physical examination of the chest reveals no characteristic signs in juvenile tuberculosis. The primary focus is so small and so lacking in collateral inflammation, and the enlarged tracheobronchial glands are so deep seated that impaired percussion note, altered breath sounds and rales are lacking. D'Espine's sign, paravertebral dullness and scattered rales are as common in undernourished children who give a negative tuberculin test as in those having any but very advanced tracheobronchial tuberculosis. Such physical signs as anemic mucous membranes, pale skin, poorly developed and flabby muscles are more common than in the non-tuberculous child, though at times those with definite juvenile tuberculosis may appear perfectly nourished and healthy.

The physical examination and laboratory examinations in the study of childhood tuberculosis are of more real value in the discovery of other abnormal conditions which might explain the symptoms than in demonstrating the presence of a tuberculous lesion. The discovery of diseased tonsils and otitis media, heart disease, or the discovery of pus in the urine, intestinal parasites or their ova in the stool, or of malarial parasites in the blood through laboratory examinations should indicate the need of caution before diagnosing tuberculosis. If there are no such defects, or if the suspicious symptoms persist after such defects are corrected, it is much more likely that the case is one of tracheobronchial tuberculosis. Tubercle bacilli are very rarely found and the complement-fixation test has not proven dependable.

The X-Ray.—The absence of definite symptoms, physical signs and laboratory findings makes the x-ray of greater value in the diagnosis of juvenile than in the adult form of pulmonary tuberculosis. In fact, it is only by the x-ray that tracheobronchial tuberculosis can be definitely demonstrated. When the lesions contain calcium the primary focus can be seen somewhere around the surface of the lung or near the interlobar fissures as a density varying in size from a small shot to a hickory nut, and the pulmonary and tracheobronchial nodes which drain the lymph from the area of this primary focus will appear as densities which are usually larger than the primary focus. They may be any shape and of any degree of density, depending upon the extent of the involvement and the amount of calcium they contain. They usually appear as granular or stippled densities. Dunham[7] considers the caseo-calcareous lymph node recognized roentgenologically by flakes of calcification in its circumference as of especial clinical significance.

Fig. 7-b (Oblique)

Fig. 7-a and Fig. 7-b. Tracheobronchial and parenchymal tuberculosis. P. F., primary focus; T. B. Gl., tuberculous tracheobronchial gland; T. B. I., tuberculous infiltration of the parenchyma.

Because the heart, large blood vessels, the sternum and the spine so frequently hide mediastinal glandular lesions it is essential that at least one oblique as well as postero-anterior films be obtained (*Fig. 3*). There should be a

pair of stereoscopic postero-anterior films and an oblique on each child. The stereoscopic are especially valuable in helping to determine whether or not a given density is at the surface and, hence, whether or not it is a primary tuberculous focus. The oblique view is also essential for the differentiating of nodular densities within the inner zones of the lung due to blood vessels caught on end or axially radiated, and thus appearing as rounded or semioval densities from tuberculous nodules. If the density is due to a tuberculous gland, it will not materially change its shape or size when rayed in another position. On the contrary the nodular density due to a vascular artefact will disappear, or appear as a line when rayed in another plane (*Fig. 4*). The oblique position which we use is obtained by placing the left anterolateral chest against the plate so that the lateral axis of the chest forms an angle with the plate of about 45 degrees. The chin is elevated and the right arm brought well up over the head.

Speed is also a requisite for satisfactory x-ray films. A technic should be employed which does not require exposure longer than 1/20 to 1/10 of a second. For this reason portable machines are not suitable.

As McPhedran[8] has shown, the size of the hilum shadow depends almost entirely upon whether or not the exposure is made during diastole or systole and, consequently, upon whether or not the blood vessels are distended or comparatively empty. For this reason a general fuzzy enlargement of the hilum is not a factor in x-ray diagnosis of tracheobronchial tuberculosis.

But even with perfect films and an expert roentgenologist the x-ray has its limitations. It is probable that only calcium-bearing lymph node lesions and hence lesions of some age and undergoing at least partial healing will cast shadows on x-ray films. The only exception is in the rare cases where the size of the hilum gland is such as to extend beyond the hilum shadow, its outline becoming apparent on account of the contrast with the air containing lung tissue. The x-ray, therefore, fails to demonstrate the lesions in their earliest stages. It is also possible that the densities represent latent or healed lesions and possibly lesions in which there are no live tubercle bacilli.

Too much emphasis cannot be placed upon the fact that a diagnosis of clinical juvenile tuberculosis rests not upon the x-ray alone or upon any other one factor, but upon the correlation of all the information which can be obtained. Suspicious symptoms, with no other discoverable cause, and a positive tuberculin test, especially if it is a well marked reaction, justify a tentative or strongly probable diagnosis of juvenile tuberculosis, even though the x-ray is negative. A history of prolonged exposure to open tuberculosis makes the diagnosis more certain. X-ray evidence of tracheobronchial lesions is not sufficient for a diagnosis of active disease without a positive tuberculin test and suspicious symptoms.

THE SIGNIFICANCE OF TRACHEOBRONCHIAL TUBERCULOSIS

Opie and McPhedran,[9] who have made a special study of this subject, state that recognizable tracheobronchial tuberculosis in children has grave significance and may serve as an index of manifest disease; also that it is evidence of prolonged exposure to open pulmonary tuberculosis.

In the more acute cases the location of the diseased glands constitutes the gravest danger. Hilum glands form the last barrier to infection of the blood stream. If the tuberculous process in these glands is a progressive one, bacilli, as they multiply, either pass from these glands into the thoracic duct and are distributed to all parts of the body through the blood stream, or they cause a necrosis with rupture of the gland capsule.

A rupture of a tuberculous gland in the cervical or other regions where its contents are emptied on the surface of the body is fraught with little danger. But when a hilum gland suppurates and ruptures, it empties either into a bronchus or a blood vessel, probably giving rise in the one case to tuberculous pneumonia (*Fig. 5*) and in the other to miliary tuberculosis (*Fig. 6*). Only a few weeks ago we held an autopsy on a thirteen year old girl in whom death resulted from caseous pneumonia of the whole right lung caused by rupture of a tuberculous gland into the right bronchus.

The great majority of cases of recognizable tracheobronchial tuberculosis are in the mildly active or latent stage. If such cases do not receive proper treatment, and especially if they are not prevented from receiving further doses of tubercle bacilli, a large per cent of them will later develop parenchymal or apical lesions of the adult type (*Fig. 7*). This is especially true during the period of adolescence. This apical lesion does not develop from an extension of the lesion in the hilum glands, but probably from reinfec-

tion from without, repeated doses of tubercle bacilli overcoming the partial immunity conferred by the previous infection.

For this reason it is particularly important that the source of infection in each case of childhood tuberculosis be discovered and that the necessary steps be taken to prevent the child from getting any further doses of tubercle bacilli. The source of the infection is usually a consumptive member of the child's household, either a relative, a boarder, or a servant. The consumptive must be separated from the child or taught to practice rigid precautions against spreading his infection.

If further massive infection from outside sources is prevented, and if proper treatment is instituted, practically all children having tracheobronchial tuberculosis, especially those over two years of age, will be arrested or entirely cured.

Fortunately, tracheobronchial tuberculosis is not only curable, but also non-contagious, since the infecting bacilli are still enclosed within the gland capsules. For this reason efforts directed toward the discovery and cure of childhood tuberculosis offer one of our greatest opportunities for the control of the great white plague.

If the clinics accomplish nothing more than the discovery of the relatively few cases of clinical and suspicious childhood tuberculosis they would be well worth while. We feel, however, that this is a comparatively small part of the good which they accomplish. By locating the 22.5 per cent of children who are infected, but who are not yet tuberculous, and by showing these children, their parents and their teachers the importance of safeguarding their health, the clinics strike at the very root of the problem of the great white plague. Many who would otherwise later in life develop tuberculosis should escape its ravages.

The interest has been so keen in this subject that we have been overwhelmed with requests for school clinics from all parts of the State. Both of our clinic physicians are already dated up for their full time through the school session of 1929-1930. The splendid cooperation of the teachers, the health authorities and the general public in the conduct of the clinics manifests an intelligent interest in the health of children which inevitably extends to all phases of anti-tuberculosis work.

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DISCUSSION *(Abstract)*

Dr. Horton Casparis, Nashville, Tenn.—Dr. McCain's study shows that it is not enough to take a history and make a chest examination if one wishes to find early tuberculosis in childhood; but by means of the tuberculin test properly used one can determine definitely whether or not a child is infected, and if he is, with the x-ray examination one can get a fair idea of the extent of involvement. This enables us to get rid of those indefinite and unsatisfactory terms which are often used, namely: pre-tuberculous children and tuberculosis suspects.

The fact that this study was made on school children, who are considered well children, brings up the point of the distinction which we commonly make between tuberculous infection and tuberculous disease or tuberculosis. If the child has a positive tuberculin test and has no symptoms we say he has a tuberculous infection, but if he has symptoms which we can refer to that infection, we say he has tuberculosis. It is my feeling that we should not draw this line of distinction too clearly, for from the pathology of tuberculosis we know that wherever there is a tuberculous focus in the body, however small, there is potential activity, even though clinically we may be unable to detect any symptom of it. We shall reach our maximum accomplishment from the preventive standpoint by considering every child with a positive tuberculin test at least a potential case of tuberculosis and by caring for him accordingly.

In connection with prevention, the question of the use of *Bacillus Calmette-Guerin* has been brought up. Judging from the work which has been done, I cannot at present think that the mouth administration of this organism will ever be of value. But the material given as a vaccine intracutaneously or subcutaneously may prove to be quite useful. With the little that is known at present about the degree of virulence of the bacillus and its stability, about all that one can say is that vaccination seems preferable in those selected individuals who are almost certain to become infected with virulent

tubercle bacilli. To three infants we have given *Bacillus Calmette-Guerin* subcutaneously.

The finding of and caring for early tuberculosis in children offers us the best means of controlling the disease.

Dr. Arthur G. Jacobs, Memphis, Tenn.—I wish to make a plea for the consideration of the adult type of pulmonary tuberculosis in the child. I think that it is far more prevalent than we suppose. Heretofore we believed that up to about fourteen years of age, probably the only kind of tuberculosis that came up was a glandular, acute miliary, or abdominal form. There is much difference of opinion here, and I believe the more carefully we look for it, the more frequently we are going to find the adult type of pulmonary tuberculosis to be present.

The tracheobronchial glands are affected in practically 100 per cent of cases and it is simple and easy for the process to extend into the peri-bronchial tissue, hilus, and lung. What is there to prevent its going in there? Is there any barrier? If so, what barrier? The post-mortem records of the Cook County Hospital showed that a very large percentage of the children who died of what was diagnosed as broncho-pneumonia and other forms of pneumonia were really cases of tuberculosis. What is the difficulty there? Why should we not be able to discover the adult type of tuberculosis in the child? Partly because of the difficulty in obtaining sputum. Of course, if we find the bacilli in the sputum we know we have the adult infection. But it is very difficult to get sputum; children do not spit; and most people will not take the trouble to obtain sputum. If you will only swab the pharynx you will make the child cough, and he will cough up the sputum.

It is true also that you may have the adult type without bacilli in the sputum, and the x-ray does not show this type well until it is far advanced. In making the diagnosis we have to take many things into consideration, among others, previous diseases. If a child has had measles or had pertussis and after that continues to have a cough and fever, consider the possibility of the adult type of tuberculosis, for there is a strong tendency for those diseases to cause the adult type. When we take everything into consideration I think we shall find we have been making a mistake when we conclude that the child can not have the adult type of tuberculosis.

When the Cook County Hospital records show that a large percentage of the so-called pneumonias in children are really the adult type of tuberculosis, I do not see how we can afford to ignore it any longer.

Dr. John A. Foote, Washington, D. C.—It would be possible, with the large number of controls you have here, to find out something about the normal temperature of children and also to find out something about the temperature in children with early tuberculosis brought out by x-ray. It might also be possible to find out something about the variation from the normal height and weight standards, as given in the tables by Baldwin and Wood, and about the degree of deviation from those who are not so affected.

Then, of course, we must not depend too much upon the tuberculin test. In the preschool period we know the tuberculin test of itself has much significance as to acute infection. But during the school age we must use this test largely as it has been used in Dr. McCain's cases, as a control for further investigation by the x-ray, before we assume that a positive tuberculin test, by itself, is evidence of a then existing infection.

Dr. Lawrence T. Royster, University, Va.—I should like to have Dr. McCain tell us how he knows that the primary focus that he indicates in his x-rays is the primary focus.

Dr. McCain (closing).—It cannot be said that there are not other primary foci of infection than the ones indicated in the lung and possibly in other parts of the body which occur at about the same time. Stereoscopic x-ray pictures of the chest show that primary tuberculous foci are located at the periphery of the lung. Does this answer your question, Dr. Royster?

Dr. Royster.—It does not tell me yet how you know it is the primary focus.

Dr. McCain.—Miller has shown that the lymph vessels in the lungs have valves, very much like those of veins, which point toward the hilum and which make it necessary for the lymph which carries the tubercle bacilli to flow from the surface toward the hilum. As Ghon and others have pointed out, autopsy findings also show that the oldest lesion, and hence the primary focus, is located at the periphery. It may be found anywhere near the periphery on any of the lung surfaces or near the interlobar fissures. The pulmonary and the tracheobronchial lymph nodes are later infected.

Almost all x-ray films will show nodular densities in the region of the hilum. It used to be thought that all of these were due to calcified tuberculous glands. It is now known that these densities are more commonly due to blood vessels caught on end or axially radiated. If the ray catches a vessel on end or at a slight angle, it makes a dot or an ovoid; if at right angles, it makes a line. For this reason, it is the more necessary to get both postero-anterior and oblique films. If a density appears in both planes without material change of shape or size, it is probably a tuberculous gland. Unless a primary tuberculous focus can be located, however, one should be very cautious about calling a density at the hilum a tuberculous gland.

I wish to emphasize the importance of carefully weighing all of the information obtainable by all procedures. Do not depend upon the x-ray alone or upon any other diagnostic procedure. Definite tuberculous densities as shown by the x-ray may be due to an arrested or healed lesion. On the other hand, early tuberculous lesions which are active may not appear on the x-ray film. Also suspicious symptoms may be due to other causes than tuberculosis. The case of a child with a definitely positive tuberculin test, with strongly suspicious symptoms persisting after other causative factors have been eliminated, should be diagnosed as tuberculous. The diagnosis is made much more certain if the lesion can be demonstrated by the x-ray.

SIGNIFICANCE OF INTERNAL PELVIMETRY AND THE APPLICATION OF THE OBSTETRIC INCLINOMETER*†

By J. Bay Jacobs, MD.,
Washington, D. C.

The relationship existing between internal and external pelvimetry is not constant. This is due to variation in thickness of bones and their overlying tissues. Williams[1] states that when Baudelocque's diameter measures between 20 and 21 cm. the true conjugate will rarely be found below 11 cm.; when, however, it measures between 18 and 19 cm., the conjugata vera is shortened in about half the cases; and when it is below 17 cm. pelvic contraction is almost uniformly present. This emphasizes the knowledge gained through mensuration of the external conjugate.

While much has been written on pelvic measurements in general, the importance of pelvic inclination has not been generally appreciated. The significance of the length of the pelvic diameters is fully realized by all obstetricians, but the determination of the angulation of the various diameters and the planes which they represent and also of the os pubis and the bony pelvis as a whole has been largely neglected.

With regard to the mechanism of labor, due consideration has been given not only to the size of the passageway, but also to that of the passenger. We know the measurements of the various diameters of the fetal head and regard a pelvis as normal when it is shaped in proportion and will allow passage of a head of normal size by natural means. Furthermore, we have carefully determined just which cephalic diameters engage in the various planes and diameters of the pelvis in all of the mechanisms and have come to regard the process as one of adaptation.

So simple a factor as imperfect flexion may interfere with adaptation and cause dystocia or even alter the whole mechanism of labor so as to make it abnormal. In this connection the importance of the forces of resistance as opposed to those of expulsion in bringing about flexion and adaptation is recognized. Yet, although the resisting forces tend to encourage the normal mechanism, so important a factor as the inclination of the planes of the pelvis and of the entire pelvis has not been given proper consideration.

It is probable that the inclination of the pelvic planes determines to a great extent the flexion or deflection of the head. Cowles,[2] in 1924, discussing 1,599 cases of occipito-posterior position, expressed the belief that a poor inclination of the pelvic inlet is in many cases a causative factor in the production of this position, probably because the poor inclination favors deflection. However, he admitted that the factor of abnormal pelvic planes as an etiological cause cannot be proved on account of a lack of facts, figures and a method by which such information can be obtained.

The inclination of the entire pelvis in the erect woman must be a great factor in determining engagement during the latter part of pregnancy and in governing the course of labor. A poor inclination of the symphysis pubis probably prolongs labor and may cause difficulty at the outlet during the termination of delivery. As a result, fetal morbidity and mortality are increased.

The term inclination is seldom used in obstetrical practice. Failure to determine pelvic inclination is probably due to the fact that most obstetricians are not familiar with any method of measuring pelvic angles and, furthermore, to the lack of a practical instrument to furnish this information directly or otherwise.

The obstetrical inclinometer devised by me is an instrument for the purpose of measuring and securing a graphic picture of the female pelvis, based on some of the following easily accessible determinations:

(1) The height and inclination of the symphysis pubis.

(2) The anteroposterior and transverse diameters of the outlet.

(3) The diagonal conjugate and the inclination of the plane in which it lies.

(4) The inclination of the plane of the outlet.

(5) The inclination of the entire pelvis in the erect woman, or the habitual inclination.

(6) The true conjugate diameter.

DESCRIPTION OF OBSTETRICAL INCLINOMETER

When assembled, the inclinometer is 17 inches in length, but it may readily be separated so as to fit the pocket. All calculations are read directly on the face of the instrument. No as-

*Read in Section on Obstetrics, Southern Medical Association, Twenty-Second Annual Meeting, Asheville, North Carolina, November 12-15, 1928.

†From the Department of Obstetrics, Georgetown University School of Medicine.

sistant is required, and the patient experiences no more pain or discomfort than during an ordinary vaginal examination. Very little time is consumed, and the instrument may be properly sterilized.

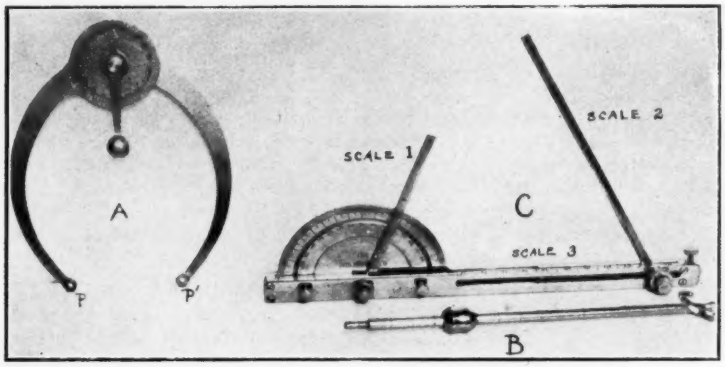

Fig. 1
The component parts of the inclinometer.
A: modified pair of calipers. B: measuring rod. C: Calculating mechanism.

The construction of the inclinometer is shown in *Fig. 1.* Part A is a modified pair of calipers with a weighted pendulum attached to the anterior surface. This pendulum is so constructed as to eliminate friction between it and the graduated disc over which it slides. When Part A is held in the upright position, the indicator records the angle of the plane in which the points P and P' lie. The distance between P and P' is read in centimeters on the posterior surface of the disc. When the calipers are applied to the symphysis pubis as in *Fig. 2,* the height of the symphysis is measured by the small indicator and the inclination of the pubic bone recorded by the displacement of the pendulum on the opposite side. The anteroposterior and transverse diameters of the pelvic outlet are measured as shown in *Figs. 3* and *4,* respectively.

Part B (*Fig. 1*) is a measuring rod 15 cm. long and 0.5 cm. thick. The end of the rod, which is inserted into the vagina, is rounded so as to avoid giving pain when it is pressed against the tissues. There is a ring near this end for the terminal phalanx of the middle finger when the end of the rod is held in various points in the pelvis. On the rod there is a sliding spool with a spring, which causes it to stay in place. The beveled edges of the spool conform to the shape of the lower part of the symphysis, thus making the measurements accurate and preventing irritation. The other end of the rod is received and fastened into Part C by a thumb-screw.

The primary function of Part C (*Fig. 1*) is to act as a prolongation of the Rod B and a support for Part A when the instrument is assembled for the purpose of measuring the diagonal conjugate diameter and the inclination of the plane in which it lies, or the conjugate of the outlet and its inclination. These points are exemplified in *Figs. 5* and *6,* respectively. The calculating mechanism determines the length of the true conjugate diameter, and its mechanical construction is such as to give accurate readings. Part C was also devised as a calculator. When not used for calculation, the scales 1 and 2 are dropped out of view and held in place by thumb-screws.

Scale 1 (*Fig. 1*) is 8.5 cm. long and represents the symphysis pubis. It slides over the face of a protractor and is fastened to subtend an angle equal to that between the symphysis pubis and the diagonal congugate. Scale 2 is then raised and its zero point shifted along the slot in Scale 3, which represents the diagonal

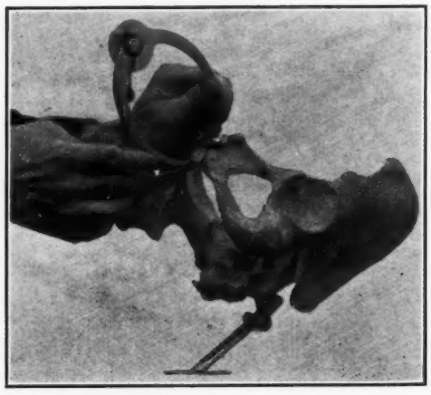

Fig. 2
Measuring the height and inclination of the symphysis pubis.

conjugate, to the point denoting the length of the diagonal conjugate diameter. This shifting is accomplished by merely sliding the thumb-screw, which has a small indicator on its upper surface. When Scale 2 is lowered, it crosses

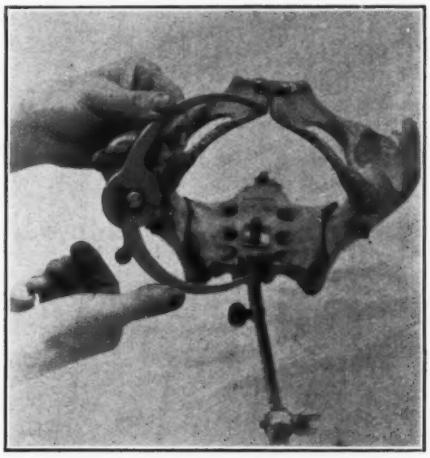

Fig. 3
Measuring the anteroposterior of the pelvic outlet.

the graduated surface of Scale 1. Its beveled edge is brought to the point denoting the height of the symphysis, where the graduations on the beveled edge of Scale 2 are coincident with those of Scale 1. The distance of the true conjugate is then read off on Scale 2 in tenths of a centimeter (see *Fig. 7*).

The height and inclination of the symphysis are measured with Part A. When A, B and C are assembled, the length and inclination of the diagonal conjugate are determined, as shown in *Fig. 5*. By means of the calculator, the length of the true conjugate diameter is determined with precision. When the measurements are laid off on the calculator, we have before us a triangle of vital importance, because it enables us to visualize the interior of the pelvis. It is an exact reduplication of the triangle formed by the symphysis pubis, the diagonal conjugate and the true conjugate. It is determined in the living woman as easily as in the cadaver. Only measurements taken from a bony pelvis could be more accurate; but in that case a determination of the inclination could not be reached, since the pelvis would be potentially disarticulated from the body. Because of its importance and the ease with which it may be measured, I suggest that the triangle visualized by the aid of the inclinometer be designated as the obstetrical triangle.

USE OF THE INCLINOMETER

For convenience, I refer to the angle between the symphysis pubis and the diagonal conjugate as the obstetrical angle. The method of determining this angle varies, depending on the station of the promontory of the sacrum as compared with the lower border of the symphysis. If the promontory is below the level of the lower border of the symphysis, the angle of inclination of the symphysis must be added to that of the diagonal conjugate. This sum is the obstetrical angle. In most patients, the promontory of the sacrum is at a lower level than the lower border of the symphysis.

If the promontory is on a level with the lower border of the symphysis, the obstetrical angle is the same as the angle of inclination of the symphysis. If it is above the level of the lower border of the symphysis, the obstetrical angle equals the angle of inclination of the symphysis minus that of the diagonal conjugate.

Comparison of two pelves with a symphysis and diagonal conjugate of normal length, but one having an obstetric angle of 70 degrees and the other 45 degrees reveals the interesting information that the true conjugate in the former is 11.8 cm., while in the latter it is 2.1 cm. less, or 9.7 cm. The importance of measuring this angle in all contracted pelves is evident.

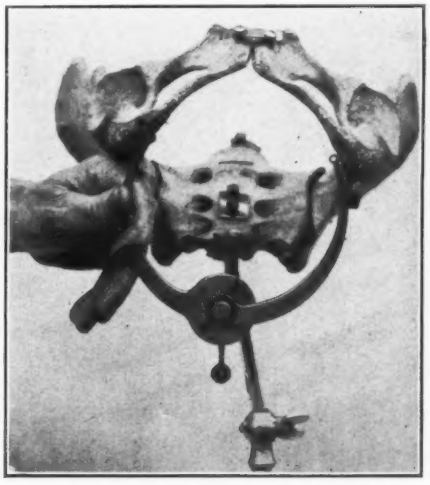

Fig. 4
Measuring the transverse of the pelvic outlet.

The true conjugate is usually obtained by subtracting 1.5 cm. from the diagonal conjugate, but many authorities maintain that this correction should vary according to the height and inclination of the symphysis pubis. However, it should be mentioned that the length of the diagonal and true conjugates and the difference between them depend not only on the height and inclination of the symphysis pubis, but also on the distance of the promontory from the pubis, the station of the promontory as compared with the lower border of the symphysis, and the angle between the pubic bone and the diagonal conjugate.

Dougal,[3] in 1913, devised a pelvigraph for recording a diagrammatic cross-section of the pelvis. This instrument was bulky and hardly portable. However, in a study of 100 cases he found the difference between the diagonal and true conjugates to vary between 0.25 inches (0.6 cm.) and 1.74 inches (4.4 cm.).

The type pelvis in which a small difference between the diagonal and true conjugates is to be desired is one presenting evidences of moderate contraction. A diagonal conjugate of normal length does not necessarily signify a normal true conjugate or even an ample pelvis. It is important, therefore, in the case of a contracted pelvis to know the exact difference between the two diameters or to determine the correct measurement of the true conjugate. The diagonal conjugate should be measured as an aid in constructing the obstetrical triangle and in establishing the length of the true conjugate. Normally, the true conjugate measures 11 cm. and is obtained by subtracting from 1.5 to 2 cm. from the diagonal conjugate, depending on the height and inclination of the symphysis pubis. The height of the symphysis is generally given between 4 and 5 cm.

Fig. 5
Measuring the diagonal conjugate diameter and the inclination of the plane in which it lies.

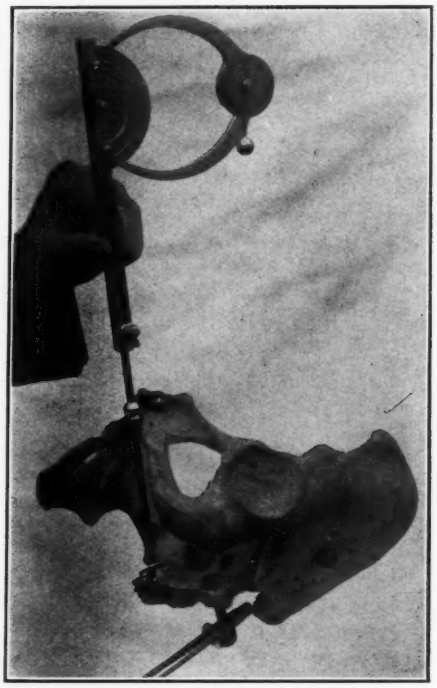

Fig. 6
Measuring the conjugate of the outlet and the inclination of the plane in which it lies.

The transverse diameter of the outlet is generally given as 11 cm., but I believe that 9.5 cm. is more nearly correct and that the thickness of the tissues in the region of the ischial tuberosities accounts for the discrepancy.

According to Cragin,[4] the position of the pelvis in relation to the spinal column varies with each change in posture. In the erect position, the base of the sacrum lies about 9 cm. above the upper border of the symphysis pubis and the tip of the coccyx about 2 cm. above the summit of the subpubic arch. Hence the plane

of the inlet and that of the outlet each make an angle with the horizon, the former about 60 degrees and the latter 10 degrees.

The angle made by the plane of the inlet is called the inclination of the pelvis. The mobility of the pelvis at the sacro-iliac joints allows of slight rotation of the innominate bones upon the sacrum, thus changing pelvic inclination with posture. With the subject lying in the lithotomy position, the plane of the inlet makes an angle of 40 degrees with the horizon; in the dorsal position with thighs extended, it is 30 degrees; in the Walcher position, only about 12 degrees.

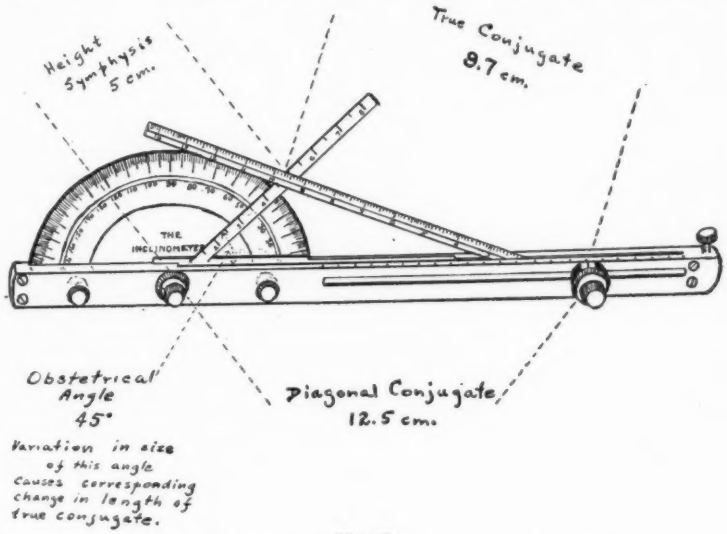
Height Symphysis 5 cm.
True Conjugate 8.7 cm.
THE INCLINOMETER
Obstetrical Angle 45°
Diagonal Conjugate 12.5 cm.
Variation in size of this angle causes corresponding change in length of true conjugate.

Fig. 7
Method of constructing obstetrical triangle for determining length of true conjugate diameter.

Meigs,[5] in 1867, emphasized the fact that the angle between the plane of the superior strait and the spinal column is altered by changes in posture. He regarded this matter as important, since upon it depends the position which the woman should assume in order to favor the entrance of the presenting part into the strait and its passage through it. A child's head that in one inclination of the pelvis would be driven against the symphysis pubis would with a smaller inclination between the superior strait and the spinal column plunge at once to the bottom of the pelvis.

If the inclination and posture are such that the head is directed against the upper border of the symphysis pubis with each pain, engagement will of course fail to take place and the repeated pressure on the fetal head with each pain will endanger the child. The duration of labor is prolonged and the uterus may become atonic or tetanic and even rupture. The danger to mother and child is thereby greatly increased.

A border-line pelvis is one in which the true conjugate is between 9 and 7.5 cm. Studies with the obstetrical inclinometer show that a pelvis with an estimated true conjugate of 9 cm. may really be small. Furthermore, when the estimated true conjugate approaches 7.5 cm., what appears to be a border-line case may really represent an absolutely contracted pelvis. On the other hand, depending upon the size of the obstetric angle, it is possible for the true conjugate to approach or even equal the diagonal conju-

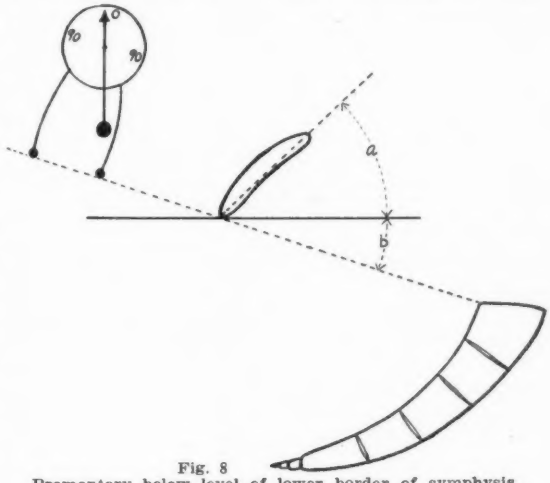

Fig. 8
Promontory below level of lower border of symphysis. Obstetrical angle equals a+b.

gate. Although most border-line patients deliver normally, I believe that subtraction of 1.5 to 2 cm. from the diagonal conjugate to estimate the true conjugate is frequently insufficient. When radical interference is required, it may often mean that the degree of pelvic contraction was underestimated and what appeared to be a borderline case was one of absolute contraction. With a given height of the symphysis and a given length of the diagonal conjugate, it is evident that the length of the true conjugate depends on the size of the obstetrical angle.

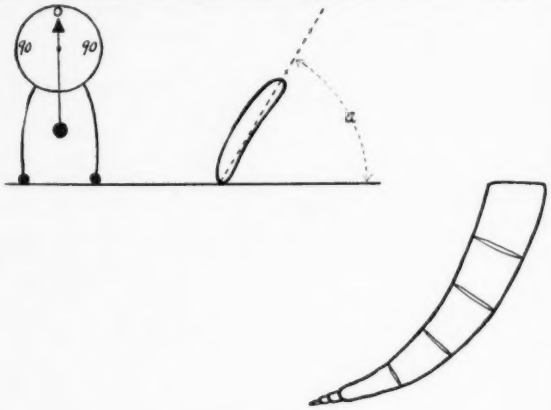

Fig. 9
Promontory on level with lower border of symphysis. Obstetrical angle equals a.

If one cannot study the pelvis in detail, he should at least be accustomed to noting the inclination of the symphysis, which may roughly be classified as good, fair or poor. If the symphysis is almost parallel with the horizon with the patient in the dorsal recumbent position, the inclination is considered good; if it is almost vertical it is poor; if the tilt of the pubic bone is somewhere between these two arbitrary extremes, as is usually the case, the inclination is considered fair. It is much easier to determine the inclination of the symphysis than that of the plane of the inlet, yet valuable information can be derived even by this procedure. When one is accustomed to noting the inclination of the symphysis, he can almost classify it by palpation.

The angle of inclination of the symphysis must not be confused with the obstetrical angle. The former is used in computing the latter. Although a poor obstetrical angle always shortens the true conjugate, depending on the acuteness of the angle, it does not always indicate a poor inclination of the symphysis. Depending on the inclination of the diagonal conjugate, there may be a good inclination of the symphysis with a poor obstetrical angle. It is also possible to have a poor angle of inclination of the symphysis, a large obstetrical angle and a large true conjugate and still encounter difficulty due to poor inclination of the symphysis. This condition, however, lends itself to treatment by postural change or manual manipulation during labor.

The pelvis should be studied with the patient in the dorsal recumbent position, as this is most convenient and comfortable for both patient and examiner. Should one or more diameters be contracted, the patient may be treated posturally during labor; that is, by Walcher position, if the inlet is contracted, and the exaggerated lithotomy position, if the presenting part is at the outlet and the latter contracted. During the examination, however, only one position is necessary, namely, the dorsal recumbent.

MAKING A PELVIGRAM

By the use of an ordinary protractor, a pelvigram or graphic representation of the pelvis may be drawn. The obstetrical inclinometer furnishes all the necessary data, including the angles and measurements.

A sample pelvigram is shown in *Fig. 11.* It may be prepared according to the following simple instructions:

(1) Draw a horizontal line (HL).

(2) Select any point (P) on that line to represent the lower border of the symphysis pubis.

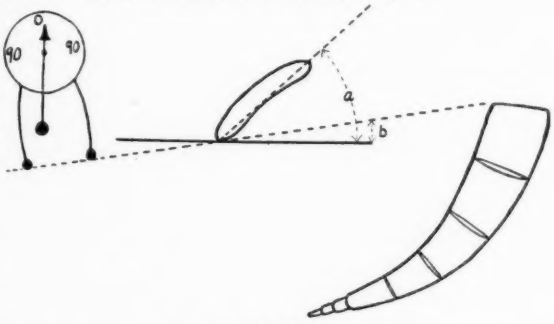

Fig. 10
Promontory above the level of lower border of symphysis. Obstetrical angle equals a-b.

(3) With a protractor lay off the inclination and height of the symphysis from P.

(4) From P lay off the inclination and length of the conjugate of the outlet.

(5) From P lay off the inclination and length of the diagonal conjugate.

(6) Now draw the true conjugate, the length of which is known.

(7) To find the inclination of the true conjugate or of the pelvis, use the protractor and place the center of it over PP, measuring the angle between the horizon (HL) and the true conjugate.

Thus we have the inclination of the pelvis with the patient in the horizontal position. The inclination of the inlet in this case is 30 degrees; of the outlet, 63 degrees. To find the inclination of the inlet and outlet, respectively, in the erect position, subtract the above figures from 90 degrees, giving an inclination of 60 degrees for the inlet and 27 degrees for the outlet.

I advise the use of the obstetrical inclinometer in all cases of suspected pelvic contraction. There is another type of woman rather commonly met with who requires complete pelvic study, namely: the short, stubby type with a high symphysis of poor inclination. The inclinometer can be used in any woman provided the presenting part is not firmly engaged. If the presenting part is well engaged, complete pelvic study is unnecessary, as the greatest diameters of the passenger have already passed the brim and the only parts of the pelvis which can cause concern are the outlet and the symphysis pubis, which can be measured even late in labor.

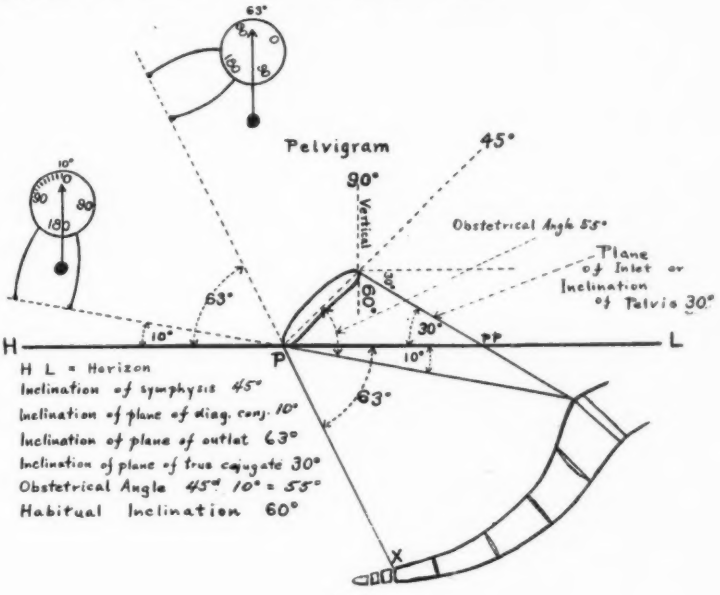

Fig. 11

SUMMARY

Although the linear measurements of the obstetrical diameters have been carefully studied, due consideration has not been given to the determination and interpretation of the inclination of the pelvis as a whole and the angulation of the pelvic planes to each other. Yet the information accorded by such a study would be of great importance in enabling us to understand and control the mechanism of labor in contracted pelvis, borderline cases, and those of faulty inclination.

A new obstetrical inclinometer is described, by which the obstetrical diameters, the inclination of the pelvis as a whole and the angulation of the various planes may be read directly on the instrument and with great precision. The instrument is portable, practical for everyday use, and not time-consuming in its use. Its application does not require an assistant and it may be properly sterilized.

By means of the inclinometer we may visualize the interior of the pelvis in the form of the obstetrical triangle, which is formed by the symphysis pubis, the diagonal and true conjugate. Studies with the inclinometer indicate that our ordinary method of computing the true from the diagonal conjugate may cause us to underestimate the degree of pelvic contraction in some cases, while it may be overestimated in others. Treatment, however, should depend not on the length of the estimated true conjugate, but the calculated true conjugate, as obtained with the inclinometer.

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The Chastleton Hotel

DISCUSSION (*Abstract*)

Dr. Asa B. Davis, New York, N. Y.—Dr. Jacobs has presented an ingenious instrument for measuring the internal true conjugate of the pelvic inlet and indicating the incline of the horizontal plane. It has a distinct value in that it is provided with a scale from which measurements can be read at once without resorting to intricate mathematical calculation. All efforts to devise means whereby we may arrive quickly at or very near a correct knowledge of the conformation and capacity of the obstetrical pelvis in the living patient are worthy of approval and encouragement. Wherever possible, we should endeavor to obtain definite knowledge. Many cleverly devised instruments have been invented for the purpose of measuring the true conjugate. They need not be employed except in select cases where other examinations have suggested a short true conjugate. Nearly all instruments for this purpose fail to indicate a double promontory, a ridge or spur of exostosis behind the symphysis pubis.

It may be permissable to call attention to the fact that after we have determined as accurately as possible, the diameters and outlines, we are still far from solving the problem of disproportion between the capacity of a given pelvis and the fetus which is to attempt passage through it. While many elaborate plans for measuring the fetus *in utero* have been published, none has come into general helpful use. There are many examples of pelves of good form, but with diameters decidedly below that which is considered normal in which easy labors are the rule. The fetus is in conformity with the capacity of the pelvis, with cranial bones susceptible of adjustment and molding if necessary. On the other hand, there appears an increasing number of women whose pelvic measurements, especially the antero-posterior diameters, are equal to or greater than the usually accepted normal size. Habitually, these women develop large fetuses with block shaped heads, thick cranial bones, narrow suture lines and small fontanelles. Such heads change their shape very little, however long trial labor may be allowed to continue. Thus, while we should welcome and approve every effort to provide exact knowledge of the capacity of the pelvis, and should continue the use of pelvimetry, experience leads us to believe that this does not go very far in assisting to solve the problem of dystocia due to disproportion between fetus and pelvic capacity.

Dr. M. Pierce Rucker, Richmond, Va.—There was one point that Dr. Jacobs did not make clear, and that is, as I understood him, he judged the obstetrical angle by two positions: first the inclination of the pubis to the horizon, and then on subsequent examinations he judged the inclination of the diagonal conjugate to the horizon. I should like to know what precautions he takes to keep the patient from changing her position. If she arched her back slightly it would throw these angles off considerably.

Dr. John Watkins, Asheville, N. C.—Many instruments have been devised for this purpose. Personally, I have never been able to use them with any degree of satisfaction or accuracy. For my own information I have learned to obtain my most reliable data from digital examination, external pelvimetry, measurements, and observation and study. This is of course not always satisfactory and in doubtful cases we have been photographing the inlet. The patient is so placed on the table that the plane of the superior strait is parallel with the x-ray plate. The distance from this plane to the plate is accurately measured and recorded. An exposure is then made, and when developed the image of the inlet can be measured. This measuring is done with a scale previously prepared on a film being the image of a lead bar marked off in centimeters photographed at varying distances from the film. The difference in the size of the image of the inlet on the plate from its true size and the difference in the size of the centimeter rulings on the lead bar from a true centimeter will be the same, as the divergence is the same in both instances. If the distance of the superior strait from the film is, say, 15 cm., its photograph is measured by the lead bar scale image photographed at 15 cm. We think this gives us an accurate measurement but it does not of course deal with the pelvic angle discussed by Dr. Jacobs.

Dr. Jacobs (*closing*).—I agree with Dr. Davis that contracted pelves are common in small women and that fortunately their babies are generally small. Occasionally, however, such patients have large babies. He has not considered the tall woman with the flat pelvis who often gives birth to a large baby. Although it is not necessary to measure every pelvis in detail, certain ones do warrant a complete study.

In many cases, knowledge of pelvic inclination is helpful and possibly a more important factor than mensuration. Thus the short stubby type woman, may be confronted with a prolonged and difficult labor, due merely to a high vertical symphysis; a condition easily detected and amenable to treatment during labor by changes in posture or bimanual manipulation. I can recall a case of a multiparous woman, all of whose children had been delivered with forceps. The cervix was fully dilated, head floating, measurements were ample and she demanded an instrumental delivery. Bimanual manipulation during pains effected engagement, and she delivered spontaneously in ten minutes. In another case, following version, unusual difficulty was encountered in extracting the aftercoming head, also due to a high symphysis with faulty inclination. Firm pressure by the assistant in the line of the axis of the superior strait, merely compressed the head against the posterior surface of the pubic bone. When at my request, he exerted force directly downward in a direction parallel to the symphysis, the head slipped through. Such a simple procedure as noting the inclination of the symphysis would help in shortening many labors, often eliminating radical interference, with a more favorable prognosis. It should be remembered, that by altering the inclination of the inlet, the forces of expulsion may be directed in the axis of that plane, with resulting engagement.

In regard to Dr. Rucker's question, as I stated before, in doing examinations of this type the patient experiences no more discomfort than during an ordinary vaginal examination. She is not apt to tilt her pelvis. After assembling the instrument I depress the perineum, with the lubricated rod between my fingers, avoiding the anterior vaginal wall, and carrying the rod with my

fingers to the promontory. If it cannot be reached I am not interested. Otherwise, I raise the rod and slide the spool down and get the length of the diagonal conjugate, at the same time noting the inclination. The instrument is not so complicated as it appears, either in use on the patient, or in calculating.

The average man has a tendency to avoid mathematics, and that was my reason for devising the calculator. It is not necessary to draw a pelvigram in every case.

Repeated use is required to develop the technic of application of this method. The method appeals to me because it is practical, accurate, and may help to promote interest in scientific obstetrics.

POST-OPERATIVE MASSIVE ATELECTASIS*†

By D. C. Elkin, M.D.,
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The introduction of a new term into medical literature, or the description of a new disease process, frequently leads to a confusion of ideas and to a misunderstanding of the fundamental factors underlying the condition. With the elaboration of these factors by various observers, and the combined reports of the disease from different angles, and with its experimental reproduction, the process undergoes a period of evolution until it can be finally classed as a definite clinical entity.

Our knowledge of atelectasis has undergone just such a change. Formerly recognized but rarely, it has of late years been the subject of numerous papers, and is now classed among the most common of all post-operative complications. In spite of excellent clinical and experimental studies, certain etiologic factors remain obscure, for while it has been reproduced experimentally, it is to be doubted that all the clinical factors influencing the production of atelectasis have been followed in the experimental production of the condition. Confusion has further arisen due to a multiplicity of definitions and descriptive terms: "massive collapse of the lung," "massive atelectasis" and "post-operative atelectasis" have been used interchangeably, and "patchy deflation" and "lobular collapse" have been described as being altogether different from the more diffuse form. However, it is probable that all are but manifestations of the same process and due to the same cause.

History.—Edward Jorg,[1] in 1832, constructed the word atelectasis (ateles, imperfect, and ektasis, expansion) to denote a failure of expansion in the new born.

In 1844, Legendre and Bailley[2] called attention to the fact that children, supposedly dying of pneumonia, were found at necropsy to be suffering from deflation of the lungs similar to that found in the fetus. They proved that they were dealing with atelectasis rather than pneumonia by tracheal insufflation, and believed that the deflation was produced by an occlusion of the alveoli, "due to the inspiratory power having been inadequate to overcome the elasticity of the lung." To Legendre and Bailley,[2] therefore, must be given the credit of first proving the nature of the condition and for first advocating a decreased respiratory force as a causal agent.

Gairdner,[3] of Glasgow, in 1853 added the theory of bronchial occlusion as a cause. This, he thought, was brought about by mucus which acted as a ball valve and only allowed air to escape from the vesicles.

West,[4] in 1874, noted the observations of Legendre and Bailley,[2] and of Gairdner,[3] and cited numerous cases of his own to support their theories of weakness of inspiratory power as a cause of atelectasis in children.

It remained for Lichtheim,[5] in 1878, experimentally to block a bronchus and to conclude that the residual air was absorbed by the pulmonic circulation, although this had previously been suggested by Bartels[6] in 1861.

The observations of Wm. Pasteur mark the beginning of our modern conception of this disease. In his first article[7] in 1890, he cited examples of lung collapse due to post-diphtheritic paralysis of the diaphragm. In the Bradshaw Lecture[8] of 1908 he further elaborated his theories and suggested that they might throw some light on post-operative pulmonary complications, but to Barr[10] must go the credit of first describing atelectasis following operation. In 1910 Pasteur[9] called attention to the fact that collapse of the lungs frequently followed operations, but he held to the theory of diaphragmatic paralysis and of failure of inspiratory power.

In 1914, Elliott and Dingley[11] reported fourteen post-operative cases and pointed out that bronchial obstruction was present in every instance. They further believed that reflex paralysis of the diaphragm was a contributing cause.

In the same year Briscoe[12] disagreed with the theories of bronchial obstruction as claimed by Elliott and Dingley.[11] He believed that quiet breathing in a supine position was largely responsible for atelectasis.

Bradford[13] noted that war wounds of the chest frequently (5 to 10 per cent) were complicated by lung collapse and pointed out that the condition often followed trivial wounds of the chest wall on the side opposite the lesion. He thought that this was brought about by reflex nervous action.

Scrimger,[14] in 1921, reported seven cases following 540 operations. He believed the atelectasis was produced by "a contraction of the muscular elements in the lung, aided by a subsequent collection of mucus."

Following Scrimger's paper, numerous clinical papers appeared in the American literature. For complete descriptions of the condition, the reader is particularly referred to the excellent papers of Scott[15] and Churchill.[16] The former believed that the mechanism of massive atelectasis was due to "a reflex blocking of the finer air passages in the affected lung tissue, quite possibly of vasomotor origin" (a theory which had been

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*Read in Section on Surgery, Southern Medical Association, Twenty-Second Annual Meeting, Asheville, North Carolina, November 12-15, 1928.

†From the Department of Surgery, Emory University.

suggested by Gwin[17]). Churchill held to the theory of "weakened respiratory force and bronchial obstruction."

Since 1925, there has been a renewed interest in the subject, as shown by numerous articles dealing with the clinical, roentgenologic, pathologic and experimental aspects. This growing interest is gradually leading to a solution of a problem which for a number of years has been the subject of numerous controversies.

Etiology.—From this historical review it is seen that atelectasis has long been recognized and described by numerous observers, but that no agreement as to the casual factors has been reached. Bronchial obstruction, respiratory paralysis, reflex vagal inhibition, and vasomotor disturbances each have their advocates, and some proof can be adduced that any or all of these may be a cause of the condition.

Bronchial Obstruction.—That atelectasis may result from obstruction of a bronchus seems proven beyond all doubt. Lichtheim[5] produced collapse in the lung tissue tributary to bronchi which he had experimentally plugged, and Jackson and Lee[18] noted it in numerous patients with foreign body occlusion.

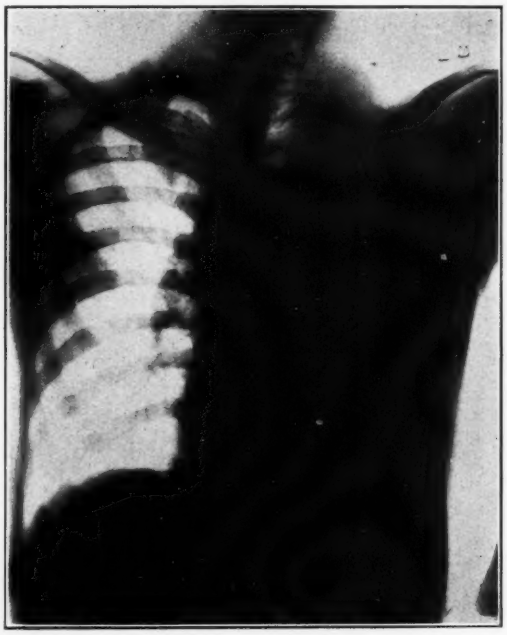

Fig. 2, Case 2
Complete atelectasis of the right lung following operation. Note the displacement of the trachea and narrowing of the intercostal spaces. The heart is completely shifted to the right side.

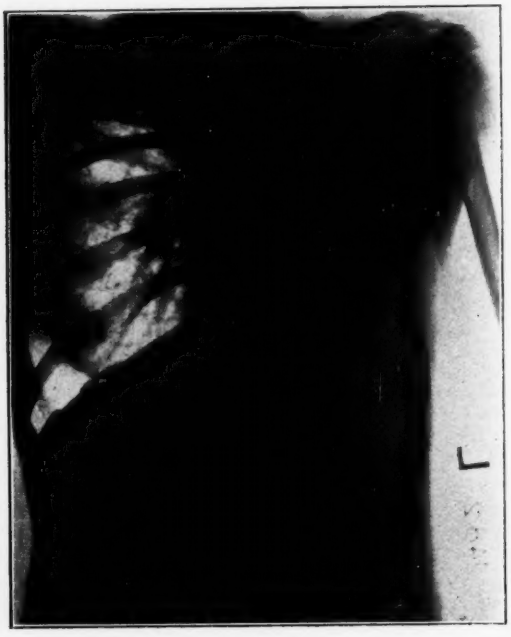

Fig. 1, Case 1
Atelectasis of the left lung due to bronchial occlusion by a metastatic nodule.

The following case illustrates the production of atelectasis from bronchial occlusion by a metastatic nodule.

Case 1.—A. B., a negress of 39, entered the Emory Division of the Grady Hospital December 2, 1926. A year previously, a small nodule had been removed from the posterior surface of the right thigh. In August, 1926, there was a recurrence of the growth, which was removed under local anesthesia, and in November, 1926, a third excision was done. At the time of entrance to the Hospital (December 2, 1926) there was a cauliflower mass about 8 cm. in diameter on the posterior portion of the right thigh just below the gluteal fold. It was partially necrotic and infected. (Biopsy showed a round-cell sarcoma.)

The liver was enlarged and thought to be the seat of metastasis, although the edge was smooth. There were no other signs of metastasis except in the lungs.

On inspection, the left side of the chest was definitely collapsed and the interspaces narrowed. On inspiration there was only slight movement on the left. The whole left lung was dull to percussion. The heart was displaced to the left side with the apex impulse in the sixth space, 2 cm.

outside the mammary line. Breath sounds were weak and distant. The right chest was normal in every respect.

Roentgenogram January 3, 1927, showed a definite atelectasis of the left lung with narrowing of the intercostal spaces and displacement of the heart to the left side (*Fig. 1*).

Estimation of the intrapleural pressure was made January 6, 1927. On the left side the pressure ranged from minus 11 mm. of mercury on expiration to minus 13.5 mm. on inspiration. The pressure on the right, or non-affected side, was practically the same.

Three other roentgenograms of the chest were made, and all showed practically the same degree of collapse of the lung, but the amount of aeration varied to some extent.

That mucous secretion will act as a foreign body in the bronchus and thus produce an atelectasis seems likewise proven. This was first pointed out by Gairdner[3] and later elaborated by Elliott and Dingley.[11] Lee[19] reported the autopsy findings in a case in which the lower right lobe was collapsed and in which the bronchus supplying it was occluded by mucus. Although Pasteur thought that respiratory paralysis was the one cause, he mentions the fact that most cases expectorated a viscid sputum, an observation of many writers[20 21 22 23] on the subject.

The following four cases developed massive atelectasis following operation and each expectorated thick tenacious sputum.

Case 2.—I. J., a negro male, age 18, entered the Emory University Division of the Grady Hospital April 13, 1926.

There was nothing of importance in his history except the story of a right inguinal hernia of three years' duration. Twenty-four hours before admission to the Hospital this hernia became caught in the scrotum and the patient was unable to reduce it.

Immediate operation was done under ether anesthesia. The anesthetist noted a large amount of bronchial mucus and the necessity of deep anesthetization to secure relaxation. Incision over the hernial mass disclosed an empty sac, with dense infiltration and edema of the tissues. The intestines were red and inflamed, but there was on evidence of gangrene. The hernial defect was repaired after the manner of Bassini.

On the following day the patient's temperature was 104° F., pulse 120, and respirations were 30. No examination of the chest was recorded. Forty-eight hours after operation the house officer noted diminished respiratory excursions on the right side with dullness and diminished tactile fremitus. The left chest was normal. The temperature was 103° F., pulse 130, and respirations were 36.

On the third post-operative day it was evident that there was something more than a pneumonia present in the patient's chest. He was inclining toward the right side, and when placed straight in bed would quickly resume that position. There was definite retraction and narrowing of the right intercostal spaces, and expansion was limited on that side. The right chest was flat to percussion except in the upper part near the sternum, where the note was that of high-pitched wooden tympany. In this area the breathing was amphoric, but elsewhere on the right side the breath sounds

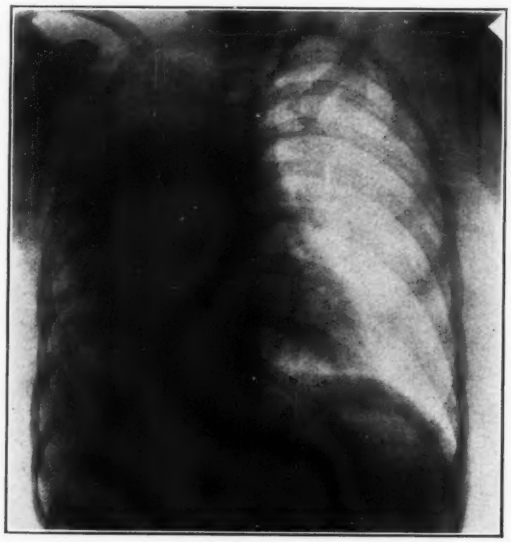

Fig. 3, Case 3
Atelectasis of the right lung following operation.

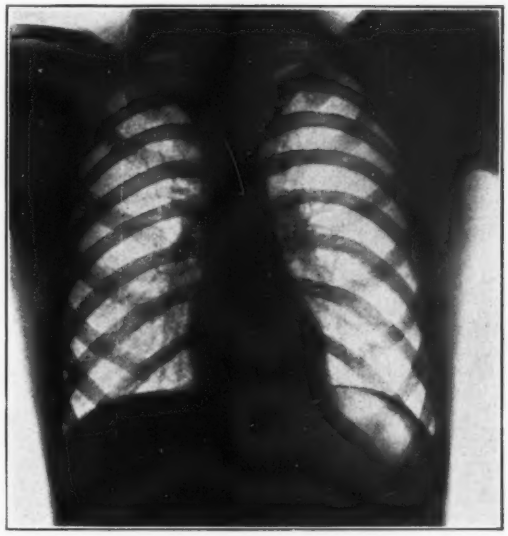

Fig. 4, Case 3
Roentgenogram of chest of same patient pictured in Fig. 3 two weeks later. Note that the atelectasis of the right lung has completely disappeared.

were absent or distant. Tactile fremitus and whispered voice were absent except over the area of amphoric breathing, where both were increased. The heart was entirely on the right side, with the left border corresponding with the left sternal margin. The right border of the heart and the liver dullness could not be differentiated from the dullness of the lung. A diagnosis of post-operative atelectasis was made and the diagnosis confirmed by roentgenogram (*Fig. 2*). During the first week after the operation the condition of the patient remained unchanged, except for expectoration of large amounts of thick, foul, tenacious sputum.

April 24, eleven days after operation, the intrapleural pressure was estimated. On introducing the needle into the right pleural cavity the pressure fell to what was equal to minus 12 mm. of mercury and on inspiration the water in the tube rose to an equal of minus 15 mm. of mercury and started over the proximal limb of the tube. The pressure on the left side ranged from minus 6 to minus 8 mm. of mercury.

The patient continued to expectorate a large amount of thick tenacious sputum, especially when placed on his left side. April 26, fourteen days after operation, there were signs of beginning aeration and a return of the heart to its normal position.

By April 30 his temperature, pulse and respirations were normal, and he was discharged from the hospital May 21, thirty-one days following operation. Three months later examination showed his chest to be normal in every respect.

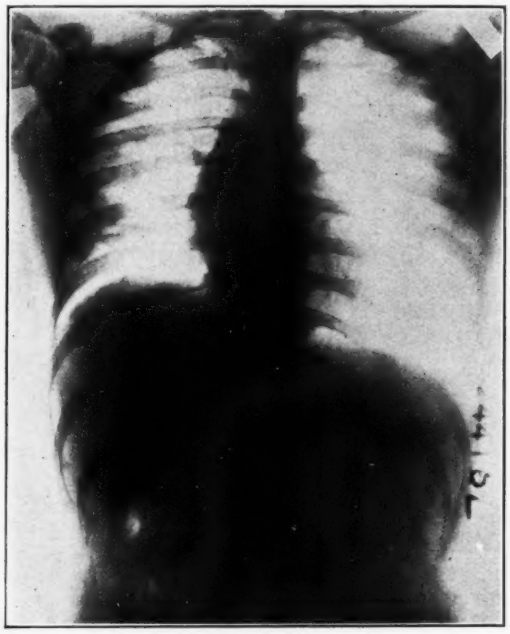

Fig. 6, Case 4
Two weeks later. The right lung is now clear, but the diaphragm has not completely returned to its normal position.

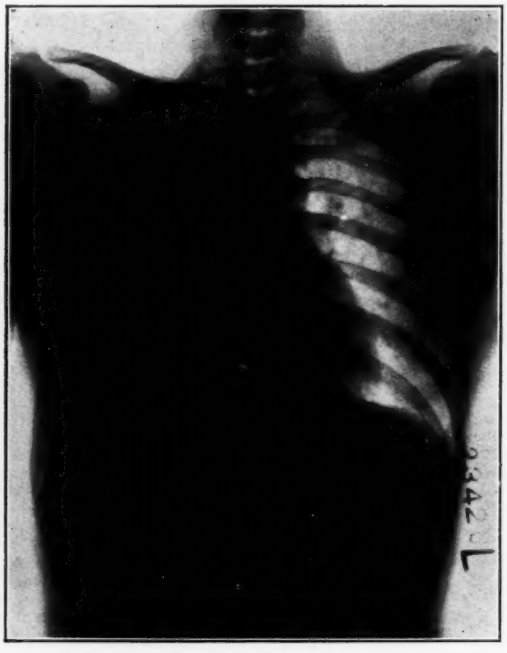

Fig. 5, Case 4
Atelectasis of the right lung. Note retraction of the right diaphragm.

Case 3.—G. W., a single male of 17, was operated upon at the Steiner Clinic August 12, 1917, for a fibroma of the thigh. Ten days previously he was found to have a subacute bronchitis and for this reason his operation was postponed. The operation was done under ether anesthesia and required thirty-five minutes.

His convalescence was normal until three days later, when he complained of pain in the lower portion of his right chest. Examination at this time showed dullness and distant breath sounds throughout the right lung. On the following day the dullness was more marked, the temperature was 102° F., pulse 130, and respirations were 40. The pain in the chest continued.

Five days after the operation it was evident that an atelectasis of the right lung was present. At this time the chest was asymmetrical with the interspaces narrowed and sunken. The breathing appeared to be limited to the left lung. The right lung was flat to percussion; breath sounds and fremitus were absent.

The heart was displaced to the right so that the point of maximum intensity of the beat was at the right of the sternum. The intrapleural pressure ranged from minus 12 mm. of mercury on expiration to minus 16 mm. of mercury on inspiration.

Roentgenogram (*Fig. 3*) showed narrowed interspaces on the right, displacement of the heart and a clouding of the whole lung on that side.

On the second day of his illness he began to

cough and on the third day began to expectorate thick yellow sputum, which continued for a week. His temperature ranged between 100 and 102° F. for four days, but on the fifth day became normal. After this the sputum gradually diminished in amount and the chest assumed its normal shape. During this time aeration gradually returned in the right lung and the heart assumed its normal position. The return to normal was gradual, and not sudden, although the patient was rolled on his left side several times daily and made to cough.

He was discharged from the hospital three weeks after operation and roentgenogram of the chest at that time was normal (*Fig. 4*).

Case 4.—C. K., a negro woman of 29, was operated upon at the Emory University Division of the Grady Hospital September 20, 1928, for myoma of the uterus, and a supravaginal hysterectomy was done under ether anesthesia. Thirty-six hours after operation she complained of pain in the right side of her chest, and at this time began to cough. The following day the right lung was dull throughout and there were moist mucous rales at the right base. The temperature was 102° F., pulse 130. A diagnosis of lobar pneumonia was made. On September 25, 1928, five days after operation, roentgeogram showed atelectasis of the right lung, with retraction of the diaphragm and displacement of the heart and trachea to the right (*Fig. 5*). At this time the cough became productive and large amounts of thick, yellow, purulent sputum were expectorated. The patient was turned on the left side several times daily and placed in Fowler's position. This apparently did not affect the condition, because aeration returned gradually to the lung and was not complete on October 4, fourteen days after operation (*Fig. 6*). The cough and expectoration gradually subsided within ten days after operation, at which time the temperature returned to normal.

Fig. 7, Case 6
Partial deflation of the left lung following peripheral trauma. The heart is displaced to the left and the interspaces are narrowed.

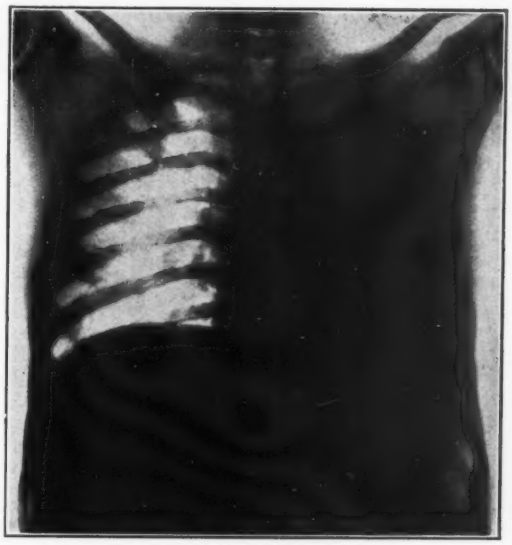

Fig. 8, Case 7
Atelectasis of the left lung due to paralysis of the respiratory muscles following beri beri.

Case 5.—W. B., a negro boy of 18, was operated upon November 9, 1928, for a ruptured gangrenous appendix. A muscle-splitting incision in the right flank was made and the appendix removed and peritoneum drained. In order to facilitate drainage, the patient was kept in Fowler's position and constantly on his right side. Thirty-six hours after operation his temperature was 103° F., pulse 110, respirations 36. There was dullness over the whole right lung with distant breath sounds and diminished tactile fremitus. The right intercostal spaces were narrowed and hollow and heat displaced toward the right. There was no cough until seventy-two hours after operation, when he began to expectorate a thick, yellow, tenacious sputum.

It was thought that this patient developed atelectasis as a result of diminished respiratory movement on account of his position on his right side and that the condition localized on the dependent side.

Further proof of bronchial obstruction is offered by Tucker,[23] who removed the secretion through a bronchoscope, and noted rapid improvement in the patients so treated. Recently Lee and his co-workers[24 25] have produced atelectasis in dogs by the introduction of the mucus obtained from clinical cases. However, they were able to do this only after the dogs' cough reflex had been abolished, and it is their belief that the removal of this reflex is necessary for the experimental reproduction of the condition.

Opposed to this view of bronchial obstruction by secretion are those who feel that some other cause initiates the condition and that mucous secretion plays only a secondary role.

Scott[15] believes that some reflex mechanism, possibly vasomotor in origin, causes a constriction of the smaller air passages, and that as a result mucus accumulates and a bronchitis is thereby produced. However, its usual unilateral nature is difficult to explain on this hypothesis unless we accept his explanation that the two sides are affected to a different degree. In this connection the observations of Scott and Joel-

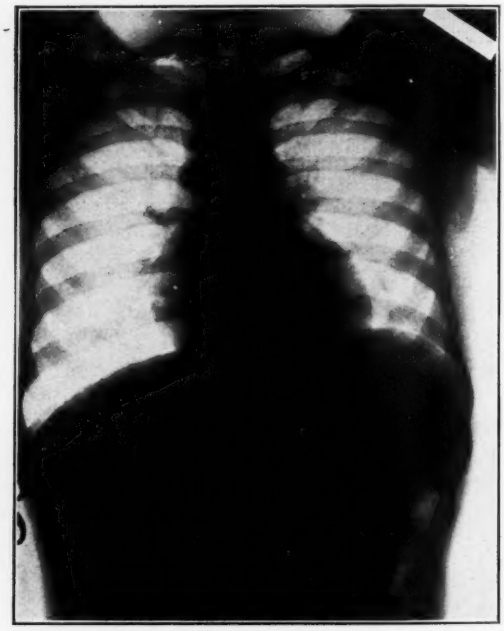

Fig. 9, Case 7

The atelectasis has disappeared and the heart has resumed its normal position. The left diaphragm has not completely returned to its normal position and is a little higher than on the right side.

son[26] are noteworthy in that "the posture of the patient seemed to determine the location which was uniformly in the dependent lung." Further proof of a vasomotor reflex causing constriction is offered in the necropsy findings in the patients of Bergamini and Shepard.[27] Their two patients suddenly stopped breathing during the course of abdominal operations and all efforts at resuscitation failed. Necropsy was immediately done in each case. There was complete bilateral atelectasis of the lungs. There was no evidence of bronchial obstruction nor any collection of mucus or secretion. There was a uniform dilation and engorgement of the capillaries, arterials and venules. The epithelial cells lining the alveoli and bronchioles were swollen and hydropic. They raise the question whether this condition is identical with or closely akin to angioneurotic edema.

Churchill believed that weakened respiratory force, as seen in post-operative conditions, combined with bronchial obstruction is the cause of atelectasis.

The following case is reported as an example of atelectasis probably due to some reflex phenomenon, and not complicated by a purulent bronchitis.

Case 6.—A. R., a white section foreman of 44, entered Wesley Memorial Hospital October 18, 1926. Three days before, as a result of a railroad accident, he suffered a fracture-dislocation of the left humeral head and a fracture of the left tibia. There was no evidence of trauma to the chest other than a superficial bruise in the axilla. There was no respiratory difficulty, no cough, no cyanosis, but the left side of the thorax was markedly retracted, and the intercostal spaces were hollowed and narrowed. The apex of the heart was in the left anterior line, and the trachea was displaced toward the left. The lung showed impaired resonance on percussion and the breath sounds were weak and distant (*Fig. 7*).

The intrapleural pressure was estimated and found to be minus 8 mm. of mercury on expiration and minus 10.5 on inspiration on the affected side. On the non-affected side the pressure ranged from minus 6 to minus 8 mm. of mercury. Three days later the left chest had regained its shape and the mediastinal structures had returned to their normal position. The resonance of the lung had returned and the breath sounds were normal.

Ten days later an open reduction of the humeral head was done under ether anesthesia and was not attended by any pulmonary complications.

A case such as this certainly suggests some reflex nervous phenomenon as a cause. It is possible that the peripheral injury in some way produced vagal stimulation, which has been shown by Dixon and Brodie[38] to cause bronchoconstriction. However, if atelectasis is already established, it has been shown by Scott[15] that atropin does not favorably influence the condition, which would lead to the belief that the bronchoconstriction was not initiated through the vagus.

Cases of this type where atelectasis followed peripheral wounds were frequently seen during the war, and many were reported by Bradford.[13]

Decreased Respiratory Force.—West[4] clearly pointed out that children with wasting diseases

frequently developed atelectasis because of weakness of inspiratory power. This theory was fully elaborated by Pasteur,[7] who noted lung collapse in post-diphtheritic paralysis of the diaphragm. Churchill[16] reports a case of atelectasis following paralysis of the intercostal muscles from a high transverse myelitis and points out that restriction of respiratory muscles from pleuritic pain may also produce the condition.

It must be remembered, however, that massive collapse of the lungs of the acute fulminating type is clinically different from a relative airless condition frequently found at the bases of the lungs following operation, or as Briscoe[12] claims as "a natural sequence of prolonged quiet breathing in the supine position."

That massive atelectasis may result from paralysis of the respiratory muscles is illustrated by the following case:

Case 7.—A negro boy of 19 entered the Hospital of the Atlanta Federal Penitentiary October 14, 1927. His condition was diagnosed as beri beri by Nellans and Massee.[29] The extensor muscles of his thighs and legs were completely paralyzed and he developed a bilateral wrist drop. There were diminished tactile fremitus, dullness and diminished breath sounds over the entire left chest. Exploratory puncture revealed no fluid. Roentgenogram of his chest showed the whole left side to be obscured by a dense shadow and the heart to be completely on the left side (*Fig. 8*). He was seriously ill for forty days, following which he began to improve and the chest completely cleared up except for a paralysis of the left diaphragm (*Fig. 9*).

Signs and Symptoms.—From the cases described, the signs and symptoms are seen to be extremely variable, depending on the severity of the condition and the extent of lung involvement. On this account Scott[15] divides the cases into (1) fulminating, (2) moderate to severe, and (3) latent forms. The onset is usually sudden. There may be pain in the chest, cyanosis, a rapid rise of temperature, pulse and respiration. The patient appears frightened, anxious, and apparently acutely ill, or the symptoms are so mild that it is not suspected unless the chest is examined.

On inspection the patient will be seen to lean toward the affected side and will invariably assume this position soon after being placed straight in the bed. There are diminished or absent respiratory movements of the affected area. The intercostal spaces are hollow and narrower than on the normal side. The one most important finding is the displacement of the apex beat toward the side of the lesion.

On percussion, the lung is flat or dull, depending on the degree of deflation. Dullness due to mediastinal structures and to retracted diaphragm can be made out, but the note over the displaced trachea will be that of "wooden tympany" and may suggest abscess. In complete deflation the areas of mediastinal and pulmonic dullness merge.

Auscultatory findings vary with the severity and stage. Breath sounds and vocal fremitus may be decreased, absent or amphoric in character. This difference will depend on the patency of the bronchi; where they are open the breathing is tubular, but when filled with mucus the sounds are absent or decreased.

Differential Diagnosis.—It is seen that these signs and symptoms, together with the picture of respiratory distress, may readily be confused with pneumonia. This mistake is avoided if due attention is paid to mediastinal displacement. The acute onset of respiratory distress must be differentiated from pulmonary and coronary infarction, embolism, and acute dilatation of the heart, and the dull, immobile chest from pleural effusion or empyema of the pleura.

The roentgen ray findings will assist greatly in the differential diagnosis, especially in those patients with incomplete deflation. The intercostal narrowing over the affected area can be accurately compared with the normal side and the displacement of the heart and trachea and the retraction of the diaphragm clearly seen.

It has been shown[30] that the intrapleural pressure is definitely lowered on the affected side, and where doubt exists an estimation of this pressure will differentiate atelectasis from other conditions which may be confused with it.

Clinical Course.—As a rule the condition subsides by lysis. After a rapid rise, the temperature, pulse and respirations remain high for a period of from three to ten days and then gradually subside. Occasionally there is rapid improvement in the signs and symptoms by crisis, but slow resolution is the rule. Rarely, after a return of aeration, deflation again takes place.

Prognosis in the unilateral cases is almost universally good, unless complicated by pleurisy or pneumonia. In the cases of bilateral sudden collapse as reported by Bergamini and Shepard[27] the outcome must be necessarily fatal.

Treatment.—Mild and uncomplicated cases

usually recover in a few days without treatment. Therefore, the wisdom of any attempt to overcome the condition mechanically is to be questioned. Scott[15] tried the effects of atropin, which resulted in an increase of the atelectasis. Morphin should be given for symptomatic relief and oxygen given if the cyanosis is marked.

With the lung collapsed and the finer bronchioles plugged with mucus, it is unlikely that forced expiratory exercises will have any effect other than further to expand the normal lung and thus increase the mediastinal displacement.

Tucker,[23] Lee[24] and their co-workers advocate removal of the bronchial secretion by means of the bronchoscope, but this seems rather radical treatment for a condition which is usually self-limited without treatment.

Sante[31] advocated the simple procedure of rolling the patient back and forth on the uninvolved side, and stated that it had proved successful in promptly re-establishing aeration in the lung. Roentgenograms made at a few minute intervals after this procedure certainly prove his contention, but it was unsuccessful in *Cases 3 and 4* of this series.

Recently Scott and Cutler[32] have suggested a post-operative regimen consisting of hyperventilation by carbon dioxid following anesthesia, Fowler's position, and a frequent change of position as a prophylactic measure, and they report one case where fully developed atelectasis was temporarily benefited by hyperventilation. If the theories of those who believe in decreased respiratory force are accepted, such measures should be of value.

The Mechanical Factors Involved in Atelectasis.—The physiology of respiration is intimately concerned with the maintenance of definite pressures both within the lung and in the pleural spaces. Moreover, the alteration of intrapleural pressure affects the intrapulmonic pressure and vice versa. It has long been observed clinically and was lately experimentally proven by Graham[33] that a change of pressure in one pleural space affects the other space to an almost equal degree.

Normally the pressure within the lungs varies from minus 2 mm. of mercury on inspiration to plus 2 mm. of mercury on expiration. In the intrapleural space there is normally a negative pressure, ranging from minus 6 mm. of mercury on inspiration to minus 2 mm. of mercury on expiration.

In atelectasis it is evident that the lung and chest wall are collapsed and that the diaphragm and mediastinal structures are displaced toward or into the affected side. A question of interest and importance is whether the collapse of the lung is active and the movement of the other structures are secondary to it, or whether the collapse of the chest wall is active and the underlying lung merely passively compressed.

Pasteur,[7] and later Bradford,[13] believed that the retraction of the chest wall and diaphragm was active, while Elliott and Dingley[11] disagreed with Pasteur's theories on the ground that only an active collapse of the lung with a subsequent lowering of the intrapleural pressure would cause mediastinal displacement toward the side of the lesion. In other words, if the chest wall collapses upon the lung, the pressure will be raised and the mediastinal structures displaced away from the area of collapse, but if an active deflating force occurs within the lung, then the chest wall, diaphragm and mediastinum are displaced toward the area of collapse.

With these facts in mind it seems evident that atelectasis must be due to some deflating

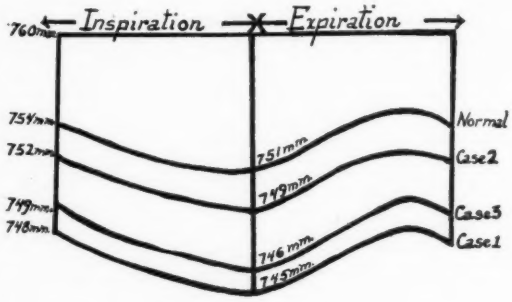

Fig. 10
Diagram representing the lowered intrapleural pressures in three cases of massive atelectasis, as compared to the normal pressure.

force within the lung itself. This deflation would be brought about by absorption of the residual air by the pulmonary circulation, provided there was no inspiration or expiration. Such a cessation of respiration would take place if respiratory movements ceased or if the bronchi were occluded.

As a proof that the collapse is due to active

pulmonic deflation with a consequent lowering of the intrapleural pressure, an estimation of this pressure has been made in four cases. In each there was a marked lowering of the pressure, thus accounting for the physical signs of rib retraction and mediastinal displacement toward the side of greater negative pressure (*Fig. 10*).

SUMMARY AND CONCLUSIONS

(1) Atelectasis of the lung following operation or trauma has been long recognized, but only of late years has been the subject of intensive study.

(2) Numerous theories as to its cause have been advocated, the most probable being bronchial occlusion, respiratory paralysis, or reflex nervous phenomenon.

(3) Seven cases are here reported: one following bronchial occlusion by metastatic nodule, four following operation under ether anesthesia, one following peripheral trauma, and one following paralysis of the muscles of respiration.

(4) While bronchial occlusion is practically always present, it is probable that some reflex nervous phenomenon is the initial cause of the condition and that bronchial occlusion by mucus is secondary.

(5) The most important signs are retraction and immobility of the chest wall with mediastinal displacement toward the side of the lesion.

(6) The retraction of the chest wall and the mediastinal displacement are secondary to an active deflation of the lung, as is evidenced by a marked lowering of the intrapleural pressure.

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DISCUSSION (*Abstract*)

Dr. J. M. T. Finney, Jr., Baltimore, Md.—Massive atelectasis is of rather rare occurrence. I have seen only two cases in the last eight years, both occurring in individuals who were rather poor anesthetic risks. They were both very obese and thick-necked, and throughout the anesthetic were poor breathers. The one case was a rather extensive dissection of the glands of the neck for metastatic carcinoma, the patient a man in the middle fifties. He was quite cyanotic and had marked rattling of mucus throughout the operation. On return to his room the administration of oxygen was begun almost immediately, but he died within four hours. At necropsy we found a complete collapse of the right lung.

The other case occurred following extensive resection of the stomach in a man in the sixties, who was quite short and stout and a poor breather throughout the operation. He developed signs which were thought to be those of post-operative pneumonia about thirty-six hours after the operation. Within another twelve hours

it was recognized as a massive collapse of the left lung. Unfortunately, he also developed a paralytic ileus, and while the chest condition improved somewhat, he died on the ninth day after operation. Necropsy revealed a not quite complete atelectasis of the left lung and a tremendously distended bowel, without any obstruction or peritonitis, a true paralytic ileus.

I have been wondering whether possibly the more restricted types of atelectasis, the so-called lobular or alveolar forms, may not occur much more frequently than we realize. We all see cases in which within thirty-six to forty-eight hours following operation there is the development of very fulminant post-operative "pneumonia," a spotty "bronchopneumonia," which disappears within a comparatively few hours much more rapidly than we would expect a pneumonia to disappear. Is this not more probably the lobular type of atelectasis, a plug of mucus stopping up a small bronchus and producing these symptoms.

Another thing that has always interested me in massive atelectasis is the rare development of true pneumonia or of lung abscess following the collapse. It seems to me this offers a very good medium for the development of either one or both of these, but so far as I know they are of rare occurrence except where we have an atelectasis due to plugging of the bronchus by a foreign body.

Dr. Howard E. Ashbury, Baltimore, Md.—Dr. Elkin refers to reduced pressure in massive collapse, which, while correct, is misleading. In normal individuals pulmonary expansion and the normal relationship of the thoracic organs are maintained by atmospheric pressure exerted intra-pulmonarily via the trachea and the suction, equally exerted in both pleura by negative pressure, the average normal being between minus 40 and minus 70 mm. of water or minus 2.54 and 5 mm. of mercury. Release of this suction by entrance of air into the pleural cavity is followed by collapse of the lung as in pneumothorax and the negative intrapleural pressure is lowered or it may become positive. If the free passage of air in and out of the lung is prevented by bronchial obstruction, the alveolar air is absorbed and the negative intrapleural pressure rises rapidly on the affected side (often as high as minus 450 mm. of water). So great may this suction become that the water in the manometer may be sucked into the pleural cavity before the needle can be withdrawn. As the negative pressure increases, the lung is drawn tightly against the chest wall, drawing the heart and vessels along with it into the affected side of the chest. Habliston and Farris advise injection of filtered air into the pleural cavity on the affected side to decrease negative pressure and for the relief of dyspnea and cyanosis, which results from lessened gaseous interchange in the over-distended contralateral lung, and also to replace the trachea toward the midline when bronchoscopy is contemplated.

Dr. Elkin (closing).—No one doubts that if the bronchus is experimentally occluded atelectasis will result. Clinically most cases of atelectasis expectorate a thick, tenacious sputum which has probably occluded the bronchus. However, it has never been satisfactorily proved that bronchial occlusion is the primary cause of the condition. Some other factors, such as a decreased respiratory force, or a reflex nervous phenomenon, may be the cause of the obstruction. The intrapleural pressure is decreased, which is only another way of saying that the negative pressure is increased.

CARBUNCLE OF THE KIDNEY*

By THOMAS D. MOORE, M.D., F.A.C.S.,
Memphis, Tenn.

Carbuncle of the kidney may be defined as an area of circumscribed, conglomerate suppurating foci in the renal cortex, of hematogenous origin, usually caused by the *Staphylococcus aureus*, and secondary to an infectious lesion elsewhere in the organism. It is a rare clinical entity which merits wider recognition. Its unfamiliarity is evident from a number of cases reported as metastatic septic processes of the kidney, the history and pathologic features of which correspond closely to that of renal carbuncle. It must not be confused with perinephric abscess, septic infarct, abscesses of the kidney, single or multiple, or focal suppurative nephritis as originally described by Brewer.[1] The term carbuncle of the kidney was coined by Israel,[2] who first described the disease in 1901. He noted the striking similarity of the condition to a carbuncle of the skin. The general acceptance of the term is evident from its employment by Barth,[3] Colmers,[4] Kretschmer,[5] Thompson[6] and others. From the English and German literature only 31 cases could be collected. There are casual references to 21 others, however, some in the Russian literature, but the details are lacking. The few cases reported may denote not only the rarity of the disease, but may be construed also as indicating the difficulty of diagnosis. There is good reason to suspect that the condition is often overlooked, especially when associated with perinephric abscess which is a frequent complication. Habein,[7] in a recent review of 44 cases of perinephric abscess of extra-renal origin, noted that there was a history of recent lesions, such as boils, carbuncles and superficial abscesses in 23. The real incidence of such infections probably is much higher, as they are often insignificant and easily overlooked by the patient. Richardson[8] collected 109 cases of perinephric abscess of extra-renal origin. He observed that furuncles preceded the abscess in 55 cases, and carbuncles in 10. Israel[2] Barth,[3] Eisendrath[9] and others, after draining a perinephric abscess, suspected a cortical renal infection because of continued pyrexia and subsequently found a renal carbuncle on exploration of the kidney. It is noteworthy that perinephric abscess was present in 10 of the 31 cases of

*Read in Section on Urology, Southern Medical Association, Twenty-Second Annual Meeting, Asheville, North Carolina, November 12-15, 1928.

renal carbuncle, detailed accounts of which were available. To the 31 cases already reported, two cases are here added.

CASE REPORTS

Case 23,920.—A woman, aged 33, on June 14, 1926, developed marked pain and tenderness in the right loin, associated with fever and urinary frequency. About six weeks before there had been a large boil on the right side of the neck. May 24, 1926, she had been delivered after a normal pregnancy, the only unusual incident being the necessity for low forceps assistance after a prolonged period of labor. Catheterization was necessary the first two days following parturition, the puerperium otherwise being considered normal. On the fourteenth day she was up and about and was discharged from the hospital. One week later a dull pain in the right loin was experienced, which was felt through and through and radiated down toward the bladder. The urine was blood-tinged. The temperature rose to 102° F. In the right renal area, both posteriorly and anteriorly, marked tenderness was elicited. The urine contained much pus and an occasional erythrocyte. A roentgen ray examination of the urinary tract was reported negative. The non-protein nitrogen of the blood amounted to 29 mg. for each 100 c. c. June 18, 1926, cystoscopic examination revealed a bladder descensus of moderate degree and 150 c. c. of residual urine. The base of the bladder was filled with sedimented purulent urine. A wax tip catheter revealed no evidence of calculus in the ureter. No. 5 catheters were passed to the kidneys and a retention of 30 c. c. of clear urine found in the right renal pelvis. No. retention was demonstrated on the left. The following data on the kidneys was obtained:

RIGHT	LEFT
Pus: five cells per high power field.	Two cells per high power field.
Erythrocytes: occasional.	Few.
'Phthalein: appeared in 4 minutes.	Appeared in 4 minutes.
'Phthalein excretion: 10% in 15 minutes.	14% in 15 minutes.
Culture: Staphylococcus aureus and B. Coli.	Sterile.

A diagnosis was made of small right hydronephrosis, infected; moderate cystocele with 150 c. c. residual urine, and acute diffuse cystitis. The bladder was irrigated daily and oral medication prescribed for the renal infection. June 26 the right renal pelvis was drained and lavaged. The urine contained only an occasional pus cell, although the temperature ranged from 102 to 104°. A No. 6 catheter was left in the right ureter for 48 hours for continuous drainage and medication. The temperature and pulse rate returned to normal for a period of five days, when a rigor and fever recurred. An indwelling ureteral catheter was employed again with prompt benefit. Dull pain in the loin persisted and at irregular intervals varying from two to fourteen days during the following three months rigors, fever and increased loin pain occurred, each time responding promptly to continuous ureteral catheter drainage (see *Fig. 1*). The leucocyte count varied from 14,200 to 16,525. A right pyelogram disclosed a moderate degree of pyelectasis. There was no apparent distortion of the calices. A cortical renal infection was suspected and on two occasions mercurochrome was given intravenously. Marked reaction occurred each time, but there was no appreciable benefit.

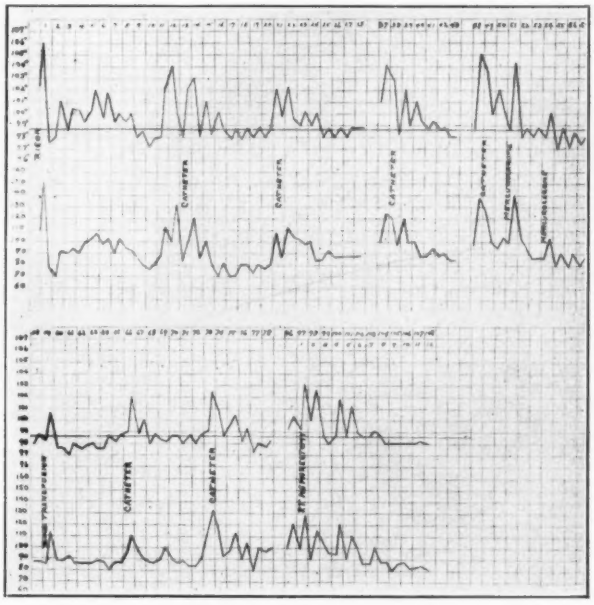

Fig. 1, Case 1

Temperature and pulse curves indicative of a septic process. Note the evidences of temporary benefit derived from use of an inlying ureteral catheter and also the prompt recovery following nephrectomy.

On August 11 a blood transfusion was given because of moderate secondary anemia and also with the view of increasing the general resistance. On September 18, after a severe rigor and fever, an exploration of the kidney was decided upon.

Operation.—A postero-lateral incision was made under ethylene anesthesia. The kidney was slightly smaller than normal and somewhat edematous. The pelvis was moderately dilated. In the middle of the convex border of the organ was a dark softened area, about 3 cm. in diameter, surrounded by a hemorrhagic zone (*Fig. 2*). The renal capsule over this area was considerably thickened, but had not perforated. Nephrectomy seemed definitely indicated and was carried out without incident. Convalescence was uneventful and the patient was permitted to leave the hospital ten days later. Three months later a repair of the cystocele and perineum was effected. She has been observed many times since the nephrectomy and has remained entirely well.

Pathological Report.—(By Dr. N. E. Leake, Pathologist, Baptist Memorial Hospital.) The kidney is slightly smaller than normal size, dimensions 10 x 5.5 x

5 cm., weight 118 grams. There are a number of vascular adhesions over the capsule and an area of dark discoloration on the convex border. On cut section the pelvis and calices are moderately dilated. The mucous membrane is slightly thickened and gray. A dark area having a yellowish center 2.5 cm. in diameter surrounded by a hemorrhagic zone is found in the cortical portion near the convex border. The remainder of the medullary portion is practically of normal color and consistency.

The microscopic examination under low magnification reveals throughout the dark indurated zone irregular areas of complete necrosis and disintegration of the kidney structure which has been replaced by multiple miliary abscesses. The cells nearer the periphery of the lesion show a lesser degree of degeneration, although the intertubular spaces are diffusely infiltrated with leucocytes and extravasated blood. Many of the tubules contain a homogenous eosin staining material through which leucocytes are scattered. Under higher magnification the cellular exudate is composed of polynuclear leucocytes and endothelioid cells which replace the kidney tissue and fill the tubules in the central part of the dark area.

Summary.—There are multiple abscesses in a localized area without liquefaction, absence of a definite zone of granulation tissue, the so-called pyogenic membrane,

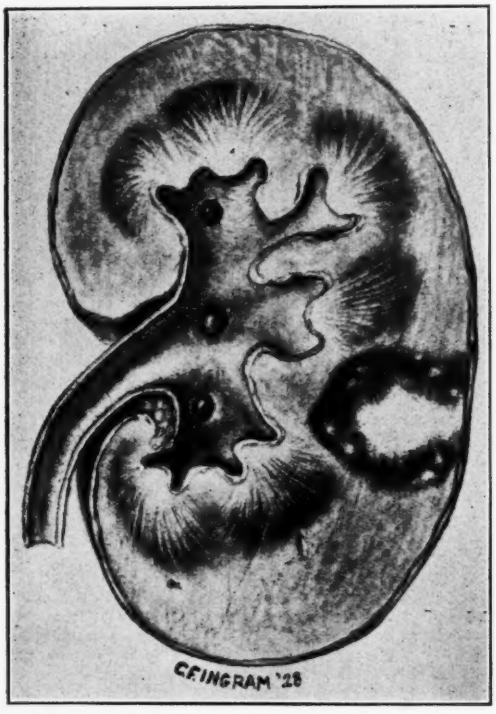

Fig. 2, Case 1
Cross section of kidney showing carbuncle near surface of convex border. Note distance from renal pelvis and the normal appearance of remainder of kidney.

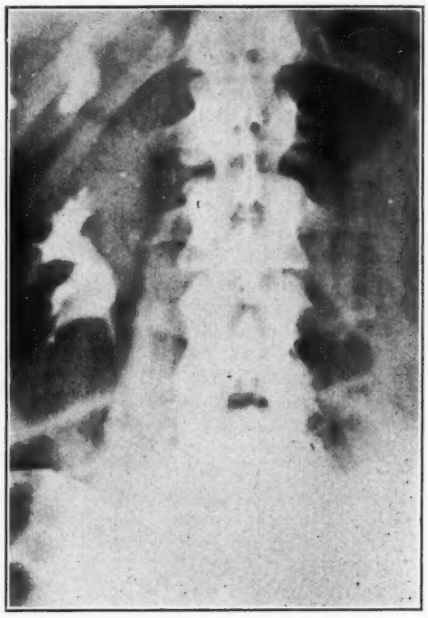

Fig. 3, Case 2
Note the elongated and narrowed lower calix. Compare with Fig. 4

and normal appearance of the remainder of the kidney parenchyma.

Pathological diagnosis is carbuncle of the kidney.

Case 28,704.—A woman, aged 40, registered at The Polyclinic October 11, 1927, because of persistent fever. Five weeks before an abscess appeared on the left elbow, which was incised and drained. A few days later an abscess developed over the left mastoid region. This was incised, following which fever appeared which has been constant, at times reaching as high as 106° F. Recently a dull pain appeared in the right loin, felt through and through, associated with moderate frequency of urination. Physical examination revealed healed scars of the recent abscesses. The heart and lungs were normal. The right kidney was easily palpable and was moderately enlarged at the lower pole, which was very tender. The tenderness was felt posteriorly as well as anteriorly. A urinalysis of a catheterized specimen was reported as follows: specific gravity 1.014, acid reaction, trace of albumin, no sugar, numerous pus cells and a few erythrocytes. The leucocyte count was 16,500. The Widal test was negative. A pure culture of *Staphylococcus aureus* was obtained from the blood. The blood urea was 45 mg. for each 100 c. c. A roentgen ray examination of the urinary tract was negative. Cystoscopic examination revealed a moderately inflamed bladder. Clear

urine was emitted by both ureteral orifices. The following data were obtained on examination of the kidneys:

RIGHT	LEFT
Indigo-carmine: appeared in 3½ minutes with slightly diminished concentration.	Appeared in 2½ minutes with deep concentration.
Pus: occasional cell.	Occasional cell.
Erythrocytes: numerous.	Few.
Culture: Staphylococcus aureus.	Sterile.

A right pyelogram (*Fig. 3*) disclosed a definite narrowing and elongation of the lower calyx; otherwise it was essentially normal. A diagnosis was made of *Staphylococcus aureus* septicemia with a localized metastatic cortical infection of the lower pole of the right kidney, probably a carbuncle. Exploration of the kidney was considered, but because of the blood stream infection it was decided first to give mercurochrome intravenously. Eight days after admission to the Hospital, during which time the temperature ranged from 101 to 103° daily, 20 c. c. of 1 per cent mercurochrome solution was injected into a vein. A sharp reaction followed with temperature of 103.8°. The fever gradually disappeared within the next few days (*Fig. 5*) and she soon felt much better generally. The enlargement of the lower pole of the right kidney and the local tenderness rapidly disappeared. The right pyelogram was repeated 17 days later with the interesting revelation of a reversion to normal of the lower calyx (*Fig. 4*). No renal infection could be demonstrated. Phenolsulphonephthalein appeared in 4 minutes from each kidney: 17 per cent from the right and 12 per cent from the left was excreted in 15 minutes. Six weeks later her general condition was excellent, no renal infection was present, the kidneys were functioning normally and equally. One year later she considered herself entirely well.

Fig. 4, Case 2
Pyelogram made seventeen days following intravenous medication. Compare with Fig. 3 and note normal lower calix.

It is admitted that the diagnosis of renal carbuncle in this case may be questioned. For obvious reasons pathologic proof is lacking. The clinical diagnosis of carbuncle, however, seems justified in view of the history of recent abscesses of the skin, followed by pain in the renal area; *Staphylococcus aureus* recovered from the blood and from the urine of the involved kidney, the function of which was diminished; a palpable enlargement and tenderness of the lower pole of the kidney with a corresponding deformity in the pyelogram, which disappeared after intravenous chemotherapy.

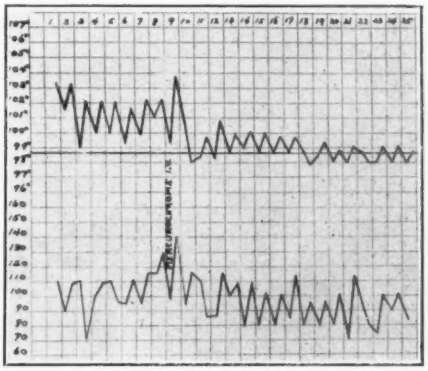

Fig. 5, Case 2
Temperature and pulse indicating rapid recovery following intravenous medication.

ETIOLOGY

Men are more commonly affected than women. Of 33 cases, including the two herewith reported, there were 12 women and 21 men. Barth,[3] Beer[10] and Colmers[4] report cases in children aged 10, which is the youngest age recorded. Zinn[11] and Reschke[12] each had patients of 55 years, which is the most advanced age recorded. Most cases occur between the twentieth and fortieth years. Trauma may be a factor, illustrated by the cases of Thompson[6] and Smirnov,[13] in which the kidney region had been the site of a recent injury. Brewer[1] demonstrated that trauma to the kidney previous to injection of bacteria practically always leads to localization in that organ. The greater incidence of the disease in men may be explained perhaps by their greater exposure to trauma.

The primary focus is usually a superficial le-

sion caused by the *Staphylococcus aureus*. In many instances the lesion was slight, was self-treated, and had healed prior to the onset of the renal symptoms. Of 33 cases, including the writer's, furuncles were mentioned in ten as the probable source. Carbuncles in various locations occurred in eight cases and infected fingers and paronchyia in five. Smirnov[13] advanced the theory that acute respiratory infections may be a focus and ascribed three of his cases to such a condition. In five cases the nature of the initial lesion remained obscure. It is probable that these represent a group in which the septic focus was a small, insignificant boil, which was overlooked or forgotten by the patient.

PATHOLOGY

In gross appearance a renal carbuncle closely resembles the ordinary one of the skin. This observation, originally made by Israel,[2] has been repeatedly commented on by more recent writers. The lesion begins in the cortex as an interstitial infection. The growth of the process is usually slow, but in exceptional cases may be comparatively rapid. In cases of Israel[2] and of Jordan[14] the renal symptoms began simultaneously with carbuncles of the neck and gluteal region, respectively. On the other hand, local renal symptoms may not appear until several weeks after a septic focus has disappeared. The virulence of the organism and the resistance of the host are the important factors in the rate of development. There are numerous suppurative foci in a localized area having but little tendency to fusion, although the numerous smaller purulent foci may be closely grouped about a large abscess. The lesion is surrounded by a zone of deep congestion which quickly merges with normal kidney tissue. The uninvolved portion of the organ remains normal to a surprising degree. The carbuncle shows little tendency to invade the renal pelvis, but rather spreads to the capsule, where perforation frequently gives rise to a perinephritis or perinephric abscess. Rarely more than one carbuncle may exist in a kidney, as occurred in a case recorded by Smirnov;[13] two carbuncles occupied the upper pole of the organ. The condition may be bilateral, as Kretschmer[5] reported, One other case of bilateral involvement, that of Rjasanzewa, is referred to by Voss.[15] Microscopically the purulent foci have the usual characteristics of suppurative lesions: necrotic debris, closely packed infiltrating leucocytes, and innumerable staphylococci. A marked fibroblastic reaction surrounds the zone of leucocytic infiltration and the blood vessels of the area are dilated. The renal tissue adjacent to the process shows very little change. There is no distinct pyogenic membrane like that which occurs in abscess formation. The *Staphylococcus aureus* is usually found in pure culture in the areas of necrosis.

Fig. 7
Note the gradual merging of the lesion with the renal parenchyma, the marked leucocytic infiltration, and the absence of liquefaction. (X 100.)

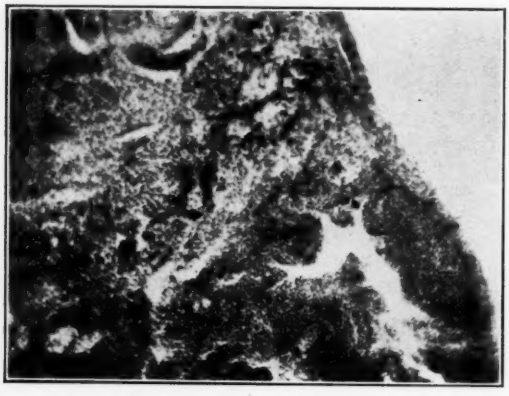

Fig. 6
Section through margin of lesion showing tendency to perforate capsule. (X 100.)

CLINICAL FEATURES

The onset of the renal symptoms usually

occurs from one to six weeks following the initial infectious lesion. This interval averaged 31 days in 25 cases. Pain in the loin may be severe, but is usually moderate and associated with definite tenderness in the costo-vertebral angle. In those cases complicated by perinephric abscess, localized swelling is also present. Fever accompanies the onset of pain and repeated rigors are not uncommon. The temperature in a majority of cases reaches as high as 104° F. Leucocytes of 10,000 to 20,000 is the rule. Higher counts occur with perinephric abscess. Localizing symptoms may be almost absent. Beer[10] reported such a case, which was carefully studied under hospital supervision over a period of 34 days before the true nature of the disease was established. Frequently the urine is entirely negative, which obviously becomes a misleading feature. Of 33 cases the urine was essentially negative in 24. Small amounts of pus and blood and traces of albumin may be present. A negative urinalysis is not difficult to understand if one recalls that the carbuncle is usually limited to the cortex and that the uninvolved portion of the kidney is essentially normal. The impaired function of one kidney revealed by a differential functional test may furnish a valuable clue, especially in those cases of continued pyrexia with no local renal symptoms.

Evidently pyelography has been employed infrequently. In Mathe's[16] case there was an elongation of the upper calyx. In one of my cases there was an elongated, narrowed lower calyx, somewhat resembling the deformity commonly produced by a neoplasm. In this case, the distorted calyx subsequently returned to normal following treatment. As in all renal infections pyelography should be used with great caution.

TREATMENT

In cases not complicated by perinephric abscess nephrectomy is usually necessary. Israel[2] and Barth[3] each reported cases in which the carbuncle was resected, followed by recovery. In cases complicated by perinephric abscess, a two-stage operation is probably safer, drainage being established not only from the abscess, but from the carbuncle as well, if possible. At a subsequent time nephrectomy can be performed with less risk. Of seven cases in which drainage was established prior to nephrectomy, all recovered. Simple drainage was used in nine cases, one of which died. A persistence of high fever and other toxic symptoms is indication for nephrectomy, as was pointed out by Eisendrath.[9] A primary nephrectomy was performed in 13 cases, including one of the author's, followed by recovery in 11. Death occurred four months later in Kretschmer's[5] case, on which an autopsy revealed a carbuncle in the remaining kidney. My case, which recovered following intravenous chemotherapy, is unique, as I have been unable to find any other case in the literature which did not require surgical treatment. From the study of 16 cases, Colmers[4] advocates nephrectomy as the treatment of choice; of these cases four died following nephrotomy, two died without any operation, ten recovered following nephrectomy.

SUMMARY

Carbuncle of the kidney is an unusual clinical entity evidently often overlooked because of its frequent association with perinephric abscess, and because of the difficulties of a definite diagnosis. The detailed findings from a study of 31 collected cases are presented and two additional cases reported. The chief clinical features of the disease are: (a) the recent history of a suppurative lesion such as a furuncle or carbuncle; (b) the appearance of dull pain in the region of the affected kidney, associated with tenderness in the costo-vertebral angle, fever and sweats; rigors may or may not occur; (c) the laboratory findings usually include a practically negative urinalysis, moderate leucocytosis and a positive culture of *Staphylococcus aureus* from the affected kidney, the function of which may be moderately diminished. Cases in which the carbuncle occupies the upper pole of the kidney may display practically no localizing symptoms. The pathologic features of renal carbuncle are well defined. Surgical interference is usually imperative, nephrectomy being the treatment of choice. In cases complicated by perinephric abscess preliminary drainage is desirable prior to nephrectomy.

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DISCUSSION (*Abstract*)

Dr. William A. Frontz, Baltimore, Md.—As Dr. Moore brought out, this condition represents a metastasis of an existing or healed staphylococcic lesion, such as a carbuncle of the neck, paronychia, or occasionally a pyelitis. It would seem from a study of the cases that the virulence of the bacterium is attenuated, which is borne out by the time which elapses between the appearance of the carbuncle in the kidney and the pre-existing lesion.

I know of no definite way to make a diagnosis. The conditions with which it is likely to be confused are multiple abscesses of the kidney and perinephritic abscess. From the multiple abscesses of the kidney differential diagnosis can be made. In most instances the lapse of time between the surface lesion and the kidney difficulty is shorter sometimes days instead of weeks. The patient is more ill and the organism concerned is no doubt of increased virulence. With perinephritic abscess I do not see how a differential diagnosis could be made. In both instances the urine usually is negative.

I had felt until I heard this paper that the treatment was surgical, and that nephrectomy should always be carried out. We expect in those cases where abscess complicates the condition that the kidney should be drained and nephrectomy done later.

Intravenous use of mercurochrome should be tried in many instances before surgical treatment is employed.

Dr. Robert W. McKay, Charlotte, N. C.—One of the things which makes urology the outstanding part of surgery is the definiteness and rationale of treatment. We cannot effectively treat hematogenous infections without knowing whether they are streptococcic or staphylococcic.

We have done a venipuncture on each case with a temperature of 101°, or above, for the past two years, and Dr. W. W. Scott, now of Rochester, N. Y., has collected in this way over 100 urological cases with blood stream infection. His publication will soon be forthcoming.

In the cultures taken at Brady Urological Institute, we obtained a number of bloods infected with *Staphylococcus aureus*, in none of which were there any symptoms of carbuncle of the kidney. Why? Perhaps, because we were dealing with an attenuated strain, or, perhaps, because the body was able to deal successfully and in short order with the invading organisms. In this connection I wish to call attention to the beautiful way in which the kidney has walled of its infection by a leucocytic wall, as shown in one of Dr. Moore's slides.

Another question that has never been successfully answered is this: when the blood stream is infected, the invading organisms are certainly thoroughly emulsified in the blood stream. Both kidneys are filled with organisms. Why, then, have we a unilateral carbuncle of the kidney or a unilateral pyelonephritis? Why are not both kidneys always infected? Apparently, one kidney has a lowered resistance, which may be caused by poor drainage, or trauma. Brewer, of New York, has done some interesting work, in which he first traumatized the kidney and then injected staphylococci into the blood stream. In the traumatized kidney, carbuncles resulted; in the kidney in which the resistance had not been lowered, no infection resulted.

In cases of perinephritis abscess with a dead kidney we should not do the nephrectomy in one stage, because, by operating in a field rich in blood supply the danger of septicemia is increased. First, we should drain the abscess, and at a later date do the nephrectomy.

The cause of the so-called carbuncles of the kidneys lie either in the degree of virulence of the organism or the condition of the patient's resistance.

Dr. E. Clay Shaw, Miami, Fla.—I have to admit that I have never seen, or recognized, a carbuncle of the kidney. I have made the diagnosis of carbuncle of the kidney twice, and in both instances apparently was wrong. The first was an abscess of the kidney which cleared up promptly following drainage. The second case was an acute condition due to a retrocecal appendix that had extended up to about the middle of the kidney.

How does Dr. Moore account for the inflammation in his operated case after use of the retention catheter?

Dr. David M. Davis, Baltimore, Md.—I saw a case of carbuncle of the kidney about a year ago. The patient could recall no boil or anything that might have been a primary lesion, and examination revealed nothing but one devitalized tooth. The urine and blood chemical analysis were negative. A pyelogram showed a filling defect; not an elongation but what might have been taken as a text-book illustration of a tumor of the kidney. The carbuncle involved nearly one-third of the kidney, and was evidently considerably older than Dr. Moore's specimen, for it was entirely surrounded by a fibrous capsule. Perinephritis was just beginning and nephrectomy was done.

There was a complete double pelvis and ureter on the

opposite side, showing that infection does not always affect the abnormal organ.

Dr. Marion H. Wyman, Columbia, S. C.—Dr. Moore mentioned that residual urine was found in the kidney which had the carbuncle. I am interested to know whether the carbuncle caused the residual urine, or did not the residual urine cause the carbuncle?

Dr. T. M. Davis, Greenville, S. C.—In all of Dr. Moore's slides the spine was straight, and there was no obliteration of the angle between the kidney and the psoas muscle. In perinephritic abscess there is always a marked concavity of the spine toward the side of the perinephritic abscess. There is also an obliteration of the angle on that side. If the abscess has been present for some time there will be a pressure defect of the renal pelvis, not like a tumor, but a decrease of the entire pelvis in the pyelogram.

As Dr. Moore states, these cases are due to *Staphylococcus aureus*, and neo-arsphenamin in 0.6 gram doses has been 100 per cent effective in the cases I have treated of staphylococcus infection. Boils, carbuncles and acne have cleared up under the administration of neo-arsphenamin for infection of the urinary tract. In a possible carbuncle of the kidney neo-arsphenamin will give better results than the use of mercurochrome intravenously.

Dr. R. A. Hennessey, Memphis, Tenn.—We have seen three cases which have conformed to the pathological description of renal carbuncle. In two cases nephrectomy was done with recovery. In a third case a subcortical abscess was opened and drained. Although the patient was in an extreme condition of sepsis, recovery and healing followed drainage. While it was apparent that marked destruction of the kidney had occurred a subsequent pyelogram showed remarkable regeneration. Urinary findings were practically negative in all three cases. While the latter case may not fulfill the pathological requirements its pathogenesis was unquestionably similar. Each case followed a superficial skin infection.

Dr. A. Mattes, New Orleans, La.—How did Dr. Moore differentiate between septic infarct and carbuncle of the kidney? It seems to me the pathological condition is more nearly that of septic infarction. Again, why was not resection attempted?

Dr. Moore (closing).—There is definite evidence indicating that uncomplicated renal carbuncle may be attended by only slight local tenderness and a moderate leukocytosis, whereas with perinephric abscess there is prone to be marked tenderness below the twelfth rib and a white count of 20,000 or more. The diagnosis may remain obscure over a prolonged period because of little or no localizing evidence. This was well illustrated by Beer's case which was studied over a period of thirty-four days before the kidney was suspected of infection. That the infecting organism is low in virulence is indicated by the usually long interval between the appearance of the original focus and of the renal symptoms, and further by the sharp localization of the infectious process in the kidney.

As to the benefit observed in *Case I* from catheter drainage, the only explanation I can offer is that in addition to the carbuncle present, there was also a hydronephrosis of 30 c.c. capacity, which evidently was repeatedly re-infected from the cortical lesion and was usually promptly relieved whenever free drainage by catheter was established.

Dr. Davis' case constitutes the thirty-fourth on record.

Infected residual urine is undoubtedly a common source of renal infection, of the so-called ascending type. However, I do not believe it was a factor in this case. The renal lesion was cortical, evidently of hematogenous origin, and there was a definite superficial focus to account for it.

Septic infarct, was considered from the pathologic standpoint and seemed definitely excluded from the diagnosis. Renal carbuncle is an area of circumscribed multiple suppurating foci. Septic infarct is usually a single lesion rather than a group of lesions. While both are cortical, an infarct has little to suggest carbuncle in appearance and the local symptoms are usually indefinite.

Dr. Hennessey's case was probably a large abscess. It is important that these should not be confused with carbuncle. Abscesses often are amenable to drainage while a carbuncle usually requires nephrectomy. In a few instances resection of the area has been successfully performed but with a high mortality. Colmer reported four cases of carbuncle treated by nephrotomy, all of which terminated fatally.

A MODIFIED TECHNIC FOR STAINING THE INTERCALATED DISCS OF HEART MUSCLE*†

By J. Edwin Wood, Jr., M.D.,
and
Robert L. King, M.D.,
University, Va.

Intercalated discs are deeply staining transverse bands scattered irregularly through the fibers of heart muscle. They are apparently characteristic of that tissue. The various theories concerning their structure and function have been discussed, notably by Palczewska,[1] Heidenhain,[2] Jordan,[3] Saphir and Karsner[4] and Cohn.[5] Whether they represent irreversible contraction bands,[6] growth centers of cardiac muscle,[2] structures brought about by stress and strain[5] or a special nutritive contrivance of heart muscle[13] cannot be discussed here. Nor does space permit comment upon their arrangement in cardiac hypertrophy[7] and atrophy.[8] That they, perhaps, represent the weakest portion of the cardiac fiber where rupture may take place[9 4] is also of interest. This unamplified and rather summary statement serves partially to introduce the structure under discussion.

Although routine preparations with the acid hematoxylin-eosin and the iron hematoxylin-van Gieson combinations usually show the intercalated discs faintly, we have been unable to manipulate these stains to give a sufficiently sharp

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*Read in Section on Pathology, Southern Medical Association, Twenty-Second Annual Meeting, Asheville, North Carolina, November 12-15, 1928.

†From the Department of Internal Medicine, School of Medicine, University of Virginia.

and detailed picture of the fiber striations and bands. Having occasion to study the intercalated discs in a recent investigation, we were advised by an experienced worker[10] in the field to use the Zimmerman technic.[11 1]

This technic consists in the fixation of small pieces of heart muscle for twenty-four hours in a solution of ten parts 25 per cent nitric acid and ninety parts of absolute alcohol. The blocks are transferred to 94 per cent alcohol containing the faintest possible trace of ammonia and washed in subsequent changes of 94 per cent until the alcohol is neutral to litmus paper. The whole block is then carried down to distilled water and thence into a 1 per cent solution of hemalum (Gruebler tablets) in distilled water, where it is left for eight days. Finally the tissue is brought back through graded alcohols, embedded in parifin, cut, fixed on the slides, passed through xylol and mounted.

The staining *in toto*, the time consumed, the hard blocks obtained by the acid alcohol fixation and the lack of sufficient tissue to run extra blocks represented our chief objections to the Zimmerman technic. We have, therefore, modified this technic for the staining of formalin fixed cut sections as follows:

(1) Fix the tissue in a 10 per cent solution of formol in 0.9 per cent saline (4 per cent formaldehyde).*

(2) Embed, cut and affix the sections to glass slides as usual.

(3) Take the slides down to distilled water and transfer them for one to three hours to a 5 per cent solution of iron and ammonia alum in distilled water. This step is not absolutely essential, but causes the formol fixed sections to take the stain more rapidly.

(4) Rinse in distilled water and place the slide for eight to twelve hours in a 1 per cent distilled water solution of powdered hemalum (Gruebler's.) The sections will now have a deep purple color, and will show little detail.

(5) Decolorize with 0.3 to 0.5 per cent hydrochloric acid in 70 per cent alcohol until the sections are a light purple, controlling the differentiation under the microscope. When the nuclei and discs are sufficiently plain rinse the slide in distilled water, carry up to xylol and mount in balsam as usual.

Neutral alcohol, iron and ammonia alum solution and aqueous acid solutions decolorize sections overstained with hemalum very slowly and are of little value as differentiators. As overstaining is essential to the proper demonstration of intercalated discs in formol fixed sections, a quick and efficient decolorizer, such as acid alcohol, is necessary.

The section used in making *Fig. 1* and *Fig. 2* has been prepared by the modified method just outlined and under the micro-

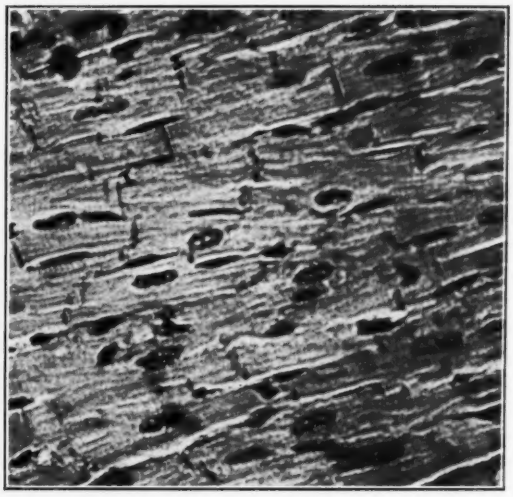

Fig. 2
High power photograph of section used in making Fig. 1. X 700. I, Intercalated disc.

Fig. 1
Heart muscle of rat stained with modified hemalum technic. X 310. I, Intercalated disc.

*To this solution add 1 per cent glacial acetic acid (1 c. c. glacial acetic acid and 99 c. c. fixing fluid). Experiments have shown that the intercalated discs stain very poorly when the heart muscle has been fixed in neutral or alkaline formol solution. When fixation is carried out in formol solution to which acetic acid has been added the discs stain well. The use of acid mordants after the tissue has been fixed in neutral or alkaline formol solution will not cause the discs to stain.

scope shows the Z lines and J discs very plainly, as well as a beautifully clean-cut picture of the intercalated discs.

Formalin fixed sections stain more diffusely with hemalum, require a longer time in the stain to bring out the intercalated discs and more decoloration subsequently. A regressive staining technic is always preferable when hemalum is used to demonstrate the intercalated discs in heart muscle fixed in formalin.

On the other hand, these discs may be stained progressively in cut sections by using the Zimmerman fixing fluid and by allowing the final change of alcohol to remain faintly acid. Sections from blocks treated in this fashion may be stained in a 1 per cent aqueous solution of hemalum as little as three or four hours and show very good staining of the discs. Palczewska[1] has noted that traces of acid permit a longer immersion of the muscle pieces in the hemalum without overstaining. This is equally true of cut sections.

Finally, it should be recorded that a 1 per cent aqueous solution of powdered hemalum (Grübler) does not acquire its full staining concentration for 10 to 12 days after the solution has been made up. If kept in the usual covered staining jar this solution will stain the discs successfully over a period of about three months. The port wine purple of the original solution then acquires a more reddish tinge, fails to stain the discs as well, but remains an excellent nuclear stain for some time. This would seem to indicate that the stain becomes more acid with age, as Mann[12] has stated that the neutral solutions are of greater value for cytoplasmic and cell structure, whereas the acid solutions inhibit the cytoplasmic staining and increase the nuclear reaction. We have not been able to demonstrate any change to a more acid state in our older hemalum solutions by a universal indicator (BDH). However, potentiometer readings have not been made. No explanation can therefore be offered by us for this change in the older hemalum solutions.

Summary.—A simple and precise modification of the Zimmerman technic has been described which permits formol fixation, the staining of cut sections, accurate differentiation and relatively rapid execution.

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DISCUSSION (*Abstract*)

Dr. Ernest W. Goodpasture, Nashville, Tenn.—A few years ago I had occasion to observe the sharp termination of necrosis of myocardial cells with the intercalated discs. I got the distinct impression that these discs mark off the muscle fibers into physiological units. In such studies as this, where one is interested in the cytology of the muscle cells, it is well to know how to accentuate these units, especially in pathological tissue.

Dr. Harry T. Marshall, University, Va.—I had the good fortune to see Dr. Wood's specimens. While the microphotographs show up those discs very well, they do not do justice to the specimens themselves. They are certainly far superior to any other photographs I have seen on this subject.

Dr. Alfred Blumberg, Oteen, N. C.—What is the objection to the use of formaldehyde and alcohol? It is my experience that sometimes formalin fixation is a disadvantage, but I wonder if in this particular instance formaldehyde and alcohol fixation would not work.

Dr. Wood (closing).—Dr. Blumberg brings up the question of the efficiency of the hemalum solution for the staining of intercalated discs in heart muscle fixed in alcohol-formaldehyde solution. Whereas we did not try this method, tissues fixed in this fluid will no doubt stain as well as they do when treated with either alcohol or formol as a fixative.

DIVERTICULA OF THE DUODENUM*

By C. H. HEACOCK, M.D.,
Memphis, Tenn.

Diverticula of the duodenum were found 14 times in 1,540 consecutive roentgenologic examinations of the stomach and duodenum at the Polyclinic, an incidence of 0.9 per cent. A study of the frequency of this condition shows considerable variation in reports from different sources. Whether the material is obtained from autopsy records, roentgen ray examinations, or surgical findings also influences the reported incidence. The highest from a large series, 3 per cent, is reported by Linsmayer,[12] whose statistics were based upon 1,367 autopsy findings. Baldwin[2] found 15 diverticula in 105 autopsies at Cornell and Schuppel[19] found seven in a series of 45 autopsies, but not another one in the next 200 examinations. Nagel[16] collected 20, or 2.2 per cent, from autopsies done at the Mayo Clinic between July, 1922, and February, 1924. Based upon the roentgenologic examination, Case[5] reports 85 diverticula in 6,847 patients; Andrews[1] 26 in 2,200 patients; Spriggs[20] 10 in 1,000 examinations; Penhallow[11] 11 in 2,200 examinations; Larimore and Graham[10] 19 in 3,446 examinations. These, together with my series, give a total of 165 diverticula in 17,233 examinations, or 0.95 per cent. The statistics quoted from autopsy records give a total of 83 diverticula in 2,617 examinations, or a percentage of 3.2. This disparity in frequency would indicate that the roentgenologists are overlooking about two out of every three cases.

Herbst[9] quotes ten theories to explain the production of diverticula. The congenital type is believed to represent an abortive attempt to form supernumerary pancreases, or are pancreatic *Anlage* producing local defects in the musculature. Acquired diverticula are due to traction from without, due to adhesions or to traction of the liver through the bile ducts. Robertson and Hargis[18] found that the distance between the pylorus and the ampulla of Vater was shortened by several centimeters in duodenal ulcer. This shortening takes place along the superior border, leaving the inferior or greater curvature border redundant and favorable for the formation of diverticula.

In addition to true diverticula, Larimore and Graham describe a "pseudo diverticulum" which is a redundancy with fixed topography, but without a defect in the walls of the duodenum. They believe this type cannot be differentiated from the true type roentgenologically. We have had one of this type which was confirmed at operation. It gave rather indefinite roentgen signs and was reported as "probably a diverticulum of the second portion." It is not included in the series of fourteen cases.

Duodenal diverticula occur most frequently in the second portion, the sac being on the greater curvature and directed toward the pancreas.

Author	Portion of Duodenum 1st	2nd	3rd	4th	Total
Baldwin	5	59	14		78
Collected by Spriggs	13	43	3		57*
Case	17	49	19		85
Cole and Roberts	3	23	2	1	29
Heacock	1	11	3		15†

This is probably explained by the factors operative in their production. However, it must be remembered that the first and second portions are most readily studied roentgenologically. The third and fourth portions are overlain by the barium filled stomach and a diverticula here, even if filled, might be easily overlooked. Moore[14] believes that many of the reported diverticula of the first portion are not true diverticula, but simply pouchings caused by the contraction of an ulcer. No cases of pouching of the uninvolved portion of the cap in duodenal ulcer are included in this series.

In spite of all the study that has been given to these diverticula in recent years, they remain largely of anatomic and roentgenologic interest. This is especially true of the congenital type. The acquired type is more important clinically because of its intimate association with the common bile duct and the pancreatic duct as already pointed out by Bell.[4] It is usually associated with duodenal ulcer, chronic cholecystitis and chronic pancreatitis.

It is not possible to distinguish the congenital from the acquired type at the roentgen ray examination and only four of this series came to operation. However, the clinical diagnosis was chronic cholecystitis in seven of the fourteen patients. The diagnosis of duodenal ulcer was confirmed by operation in another case. There was one case each of chronic appendicitis, of portal cirrhosis, and of pernicious anemia. In

*Read in Section on Radiology, Southern Medical Association, Twenty-Second Annual Meeting, Asheville, North Carolina, November 12-15, 1928.

*Two were multiple, occurring both in first and second portions.

†One was multiple, occurring both in second and third portions.

the other three there were no symptoms referable to the gastro-intestinal tract. When symptoms are present they are usually due to the associated disease, but the presence of the diverticulum often confuses the picture. Hartung[8] collected several cases from the literature in which there was an associated diverticulitis; and also a few cases of duodenal obstruction, caused by pressure from the filled sac.

Although the great majority of diverticula of the duodenum are without clinical significance, patients have been relieved of their symptoms occasionally by the surgical removal of them (Forssell and Keys,[7] Basch,[3] E. C. Moore,[15] Lewis,[11] and Lund[13]). In the selection of those cases which may be benefited by surgery, the roentgenologist may be of assistance to the surgeon. By observing the presence or absence of spasm and local tenderness, he may determine if a diverticulitis is present. The degree of obstruction to the duodenum can be detected. Whether or not there is retention in the diverticulum is easily observed, but it is questionable whether a retention is an index to the role of the diverticulum in producing clinical symptoms.

The roentgen ray offers the only means of making a diagnosis before operation. The characteristic finding is a localized collection of barium with a circumscribed smooth border, extra-luminal but usually having a demonstrable connection with the lumen of the bowel. Frequently, a gas bubble overlies a fluid level in the sac. During the fluoroscopic examination the opaque media can be seen to enter the sac from the duodenum. Direct pressure and manipulation will often cause a part of the contents of the pouch to flow into the duodenum again. Since examination of excised diverticula shows no muscular coats or very deficient musculature, retention is common. The diverticula may be of any size and have their ostia at any level. As they become larger, their weight is apt to drag them downward so that the ostium comes to occupy the uppermost portion of the pouch. Often the first suspicion of a diverticulum is aroused by the retention after the stomach and duodenum are empty. This is especially true in those diverticula that are retro-gastric. Nine of the fourteen diverticula in this series showed retention at the five-hour observation.

Any shadow lying in close vicinity to the duodenum may be mistaken for a diverticulum. Cole and Roberts[6] divide these into two groups: (1) those not due to barium and (2) those that are visualized as a result of being filled with barium. In the first group are all the various calculi, gall stones, renal stones, and pancreatic stones. Other localized areas of calcification as mesenteric lymph glands and even fecaliths must be considered. These rarely cast as dense a shadow on the fluoroscopic screen as barium sulphate. Manipulation of the patient will establish them as distinct from the duodenum and palpation will reveal their non-fluid nature. A roentgenogram of the abdomen, made on the Bucky diaphragm prior to the ingestion of the barium, will reveal all shadows dense enough to lead to confusion in the differential diagnosis.

Fig. 1
Diverticulum of first portion of duodenum, associated with a duodenal ulcer. Proved at operation.

Shadows cast by the barium mixture are of the same density and the differentiation of these sacs from other barium accumulation is more difficult. The latter include the so-called pseudo-diverticula, perforated duodenal or gastric ulcer with the formation of an accessory pocket, sac-

culations due to the contraction of ulcer scars, and isolated residues of barium from a previous examination in the haustra of the transverse colon. Following a fistula between the gall bladder and the duodenum, or following a cholecyst-duodenostomy, the gall bladder may fill with barium and give the appearance of a diverticulum. No more important point can be raised in the differential diagnosis than a study of the ostium and the demonstration of a back

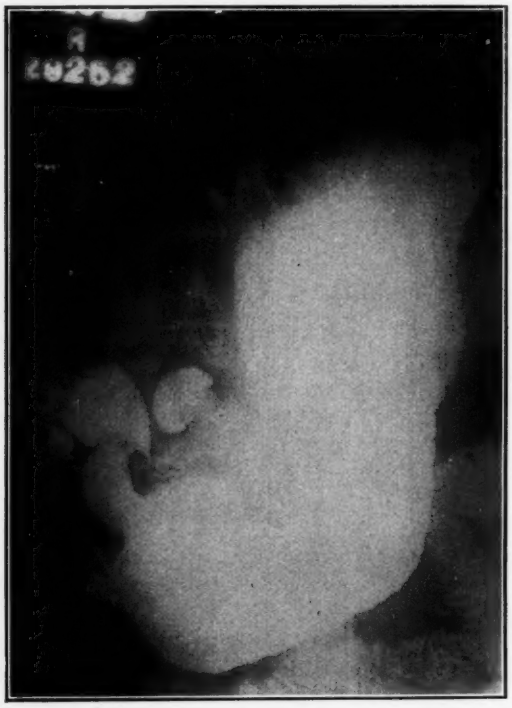

Fig. 2
Multiple diverticula. Patient did not have surgical treatment.

and forth flow of the media from the lumen of the duodenum to the cavity of the sac. Most of the lesions which give rise to difficulty in the differential diagnosis are situated proximal to the second portion of the duodenum. Most of the diverticula of the duodenum occur in or distal to the second portion. By passing a duodenal tube through the empty stomach and cap, the remaining portion of the duodenum can be studied to infinitely greater advantage. This is the second most important point in the differential diagnosis. I recently had a sac which filled up suddenly near the lesser curvature of the stomach after the barium was passing freely through the pylorus. I was not able to determine whether the overflow was from the stomach into a large niche or accessory pocket, or from the third portion of the duodenum into a sac. A duodenal tube was passed into the third portion of the duodenum after the stomach was empty, but the sac about one-third filled. Filling the duodenum with barium failed to show any connection between the sac and the duodenum. Re-administration of barium demonstrated that the sac filled from the stomach. Whether this was a large perforated gastric ulcer or a gastric diverticulum has not been proved.

Attention has been called to dilatation of the ampulla of Vater as a concomitant sign of cholecystic and pancreatic disease. This dilatation has been proved many times both surgically and at post-mortem examinations. But it is questionable whether these dilatations can be called true diverticula because they are not blind sacs. Since the most common location for diverticula is at the ampulla, doubtless many cases of dilated ampullae are called diverticula. No reliable method of differentiating them roentgenologically exists and one small outpouching was excluded from this series because it was felt that it might belong to the classification of dilated ampulla of Vater.

Undoubtedly an interest in the presence of diverticula will lead to their being discovered more frequently. Most of the cases here reported have been found recently, and in every instance they were found only when a special search for them was instituted. Too frequently we confine all our attention to the cap and neglect to study the remainder of the duodenum. Their lack of clinical significance cannot be offered as an excuse. Every case examined may have surgical treatment and the surgeon is entitled to all the knowledge a roentgenologist can give him in advance as to anatomy, anomalies or pathological conditions. Since they may be simulated by conditions of utmost clinical significance, as perforated ulcer, they become more than roentgenologic curiosities. In the differential diagnosis no procedure is more important than the filling of the second, third and fourth portions of the duodenum with barium through a duodenal tube.

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DISCUSSION (*Abstract*)

Dr. D. B. Harding, Lexington, Ky.—The diagnosis of duodenal diverticula is purely a radiological problem. As Dr. Heacock has stated, there is a considerable degree of error in the roentgen diagnosis of these lesions, and special study is often necessary to demonstrate them. The method of filling the duodenum with barium through a duodenal tube should be a very valuable diagnostic aid.

As most diverticula are found in adults, it is probable that they are not entirely congenital in origin. Reexamination of patients in whom diverticula have been found, over a period of several years might show changes in the lesions which would be of value in determining this point.

The increasing number of reported cases in which symptoms have been relieved by surgical removal of diverticula suggests that not all of these lesions are symptomless. Distention of the thin walled sac during vigorous duodenal peristalsis has been thought by some observers to cause pain. I have been unable to note any appreciable dilatation of diverticula during fluoroscopic observation. However, I have seen two cases in which diverticula apparently emptied by muscular contraction of the walls of the sac.

I have not seen, or at least not recognized, the pseudo-diverticulum described by Larimore and Graham. I believe this condition could be differentiated from the true diverticulum by the shadow of the normal duodenal mucosa, showing evidence of Kerkring's folds. Most true diverticula have a smooth lining unlike the mucosa of the normal duodenum.

Dr. Heacock (closing).—I have never seen shadows suggesting valvulae conniventes in these sacs. The borders are quite circumscribed, as you have seen. The folds of the mucosa are obliterated by the distension of the sac.

I believe the most important point in differentiating the pseudo from the true diverticulum is in the study of the ostium. The true diverticula have narrow ostia, while the pseudo-diverticulum has a base that is really the broadest portion of the entire sac.

Dr. Harding's observation of peristalsis is certainly unusual. The musculature of the sacs is so deficient that any effective peristalsis is impossible.

CHOREA: A CONSIDERATION OF ITS VARIOUS FORMS*

By BEVERLEY R. TUCKER, M.D.,†
Richmond, Va.

In the search for the new and odd in medicine we are prone to neglect the old and frequent. In surveying the literature of chorea I find dozens of forms of so-called chorea described. This multiplicity of forms is largely due to the error of describing the symptom of choreiform movement as a disease or syndrome.

Chorea as an entity must, in my opinion, conform to certain definite conditions, and all muscular movement disorders or symptoms not so conforming should be discarded. These criteria are:

(1) Multiple muscular movements which must be spontaneous, irregular, involuntary and purposeless.

(2) These movements must be reasonably traceable to the action upon certain portions of the brain: (a) of a toxin from some form of infection, (b) of some form of bacterial invasion, (c) of some hereditary or acquired degenerative condition.

(3) Chorea must be considered in the light of an encephalitis.

Thus are eliminated from the consideration of chorea such phenomena as athetoid movements, habit or other spasms, the myoclonies, tics, drug poisons causing muscular movements, torsions, rhythmic movements, functional movements, imitative movements, convulsive movements, tremors and movements due to disease or injury

*Read in Section on Neurology and Psychiatry, Southern Medical Association, Twenty-Second Annual Meeting, Asheville, North Carolina, November 12-15, 1928.

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which are not associated with encephalitis. I do not believe that Dubini's so-called electric chorea with its lightning-like movements, convulsions, atrophy and reaction of degeneration, or that Bergerson's rhythmic movements occurring in anemic children should be classified as chorea.

By the elimination suggested we may confine the discussion of chorea to the following seven forms:

(1) Sydenham's, or acute infectious chorea.

(2) Huntington's, or chronic family chorea.

(3) Hereditary, or chronic congenital chorea.

(4) Senile, or arteriosclerotic degenerative chorea.

(5) Chorea gravidarum, or the chorea of pregnancy.

(6) Chorea associated with epidemic encephalitis.

(7) Chorea of acute infectious diseases.

Common to all these forms of chorea are irregular, asynergic, spontaneous, involuntary movements. These movements may begin in one extremity or locality, but they usually spread rapidly to become bilateral. At times, however, the movements may remain local or become hemi-lateral. The movements may involve the muscles of the lips, tongue, palate, neck, trunk, extremities and the muscles of respiration. The movements may be so slight as to require close observation for detection, or so severe as to cause, as I once observed, the patient to throw himself involuntarily over the eighteen-inch sides of a bed, like a caught fish flopping over the sides of a boat.

All of the forms of chorea mentioned may be considered due to the action of toxin, infection or degeneration upon the cells of some part of the central nervous system. All seven forms may be considered in the light of encephalitis. Autopsy reports in chorea have varied in a remarkable degree. It seems quite certain, however, that encephalitis occurs in irregular areas in these cases and that these areas may, and usually do, involve the cerebral cortical cells, the basal ganglia, especially the corpus striatum, the cerebellum, and the rubro-thalamo-cortical extensions of the cerebella pathways. At times the pia, the arachnoid and the prefrontal lobes, the medulla and the cord may also be involved. The capillary blood vessels are frequently dilated and there are present perivascular infiltration with punctate hemorrhages and granular degeneration. In senile chorea and Huntington's chorea sclerotic patches may be observed.

We shall now briefly discuss each of the seven forms of chorea, mentioning only certain points that appear to be of some special interest.

Sydenham's chorea seems so definitely associated with that form of streptococcic infection producing arthritis and rheumatoid endocarditis that it behooves us to make a diligent search for focal infection. This, in our experience, has been most frequently found in the tonsils. The removal of the tonsils, however, should never be done in the presence of an elevation of temperature and it is our custom to wait not only until the temperature, but also the gross movements and endocarditis have subsided. In treatment, in addition to the usual rest and isolation, we have obtained the best results with tepid soaks or packs, salicylates and chloretone. During the convalescent stage we give arsenic and massage.

Huntington's chorea occurs at any age, but usually in adults, and mental aberrations, together with other cases occurring in the family, are outstanding. We recently reported a case.* The patient's movements are less severe if the emotions are not stimulated by exertion or by excitement. No treatment is of avail. Death may occur as early as three or as late as fifteen years after the onset.

Hereditary or chronic congenital chorea is more apt to appear among those who are idiotic, imbecile or feeble-minded, but it occurs occasionally in those whose mentality is quite normal. Treatment in these cases is of no avail.

Senile or arteriosclerotic chorea occurs after middle life and is indistinguishable from Huntington's chorea except that there is no family tendency toward the disease, and the movements and mental disturbances usually appear later in life. Mental deterioration occurs as part of the disease. We have recently reported a case.*

Chorea gravidarum, or the chorea of pregnancy, occurs during or shortly after pregnancy. The prognosis is extremely grave and future pregnancies should be prohibited. Mental symptoms seem especially prominent. We have recently reported a case with recovery.*

Chorea associated with epidemic encephalitis occurs as part of the encephalitis. It is not so common as theoretically would seem probable. We have recently had a case in which the encephalitis began with influenza and was complicated by severe toxic hyperthyroidism and infected tonsils. Marked improvement took

*Tucker Sanatorium Bulletin for September, 1928.

place after rest in bed, the administration of Lugol's solution, thyroidectomy and tonsillectomy.

The chorea of acute infectious disease is also rare and is due to a complicating cerebritis. It may occur during the course of scarlet fever, typhoid, diphtheria, influenza, and rarely in acute cerebrospinal syphilis.

Choreic movements have occurred as a complication in paresis, brain injury, brain hemorrhage, brain tumor, and in hyoscine poison, but in these the manifestation is that of a symptom rather than of an entity.

The muscles in the various forms of chorea show marked hypertonia as a rule. The deep reflexes may be variable in amount, but they are always present. Elevation of temperature is a factor in Sydenham's chorea, in chorea gravidarum, is occasionally present in the chorea of acute epidemic encephalitis, and, during the acute stage, in the chorea of acute infectious disease. Temperature elevation is absent in Huntington's, chronic and senile chorea. In any form of the condition the speech may be affected and is usually of a mumbling, thick, indistinct character. Deglutition, chewing and respiration are frequently affected. Any form of chorea may be accompanied by hallucinations and occasionally delusions. Retardation of the thought processes is common. In many cases there is a change in personality, which may consist of impatience, irritability, tantrums, carelessness, hypersensitiveness, and even more gross conduct disturbance.

In conclusion I would say that the ideas of the medical profession in regard to chorea have undergone many changes and transformations. Originally chorea was considered a functional condition with a family neurotic tendency in the background. It was then looked upon as a form of infectious disease of childhood, and later as an irritative phenomena of the cerebral cortex alone. During these periods every conceivable movement, torsion and muscle phenomenon were classified as chorea. These classifications have been discarded for the present view which is that chorea may be divided into seven forms, all of which are due to an irregularly distributed encephalitis involving not only the cortex, but also the basal ganglia and cerebellum or cerebella pathways. A consideration of the whole subject has led me to the conclusion that the three criteria mentioned, first, of spontaneous, irregular, involuntary movements; second, movements which are due to toxic, bacterial or degenerative invasion; third, involvement of areas of the brain which must be considered in the light of an encephalitis, must all be present to confirm the diagnosis of chorea. Further, cases not so conforming should not be considered under the head of chorea.

DISCUSSION (*Abstract*)

Dr. H. Mason Smith, Tampa, Fla.—Dr. Tucker has so described the symptoms that a diagnosis of the true chorea is decidedly simplified, although this criterion of irregular, spontaneous, involuntary and purposeless movement may be found occasionally in a child with a neuropathic, nervous background, and the diagnosis may be clouded by hysteria. It does not take much intoxication to bring about this condition in a neuropathic child. A student in a rural school caused an epidemic of chorea which spread to most of the students in the school. Of course, all were hysterical, but some were mixed with a true Sydenham's chorea.

Dr. Tucker's description of cerebritis reconciles the opinion of all the authors who have described vascular conditions, or infectious toxemias in the brain, and also reconciles the description of Drs. Pointer and Holmes of a cerebral rheumatism in infectious diseases such as scarlet fever.

In the treatment of minor chorea after the infectious focus has been eliminated, the tepid baths received in the warm water of the Gulf of Mexico, supported by the tonic salt that is there, and the solar rays on the beach, have had the most delightful therapeutic influence on all of these cases that have come in my practice.

AN IMPROVED DIAGNOSTIC NEEDLE AND ANTRUM PUNCH*

By G. M. Maxwell, M.D.,
Roanoke, Va.

There are two objections to the commonly used diagnostic needle for maxillary sinus work.

First.—Often, in passing through the sinus wall, the needle picks up a fragment of bone, which blocks its end and the withdrawal of the needle is required to remove the particle: or (what may be a more serious matter) this small piece of bone is dropped into the sinus, where it may act as a foreign body and cause later trouble.

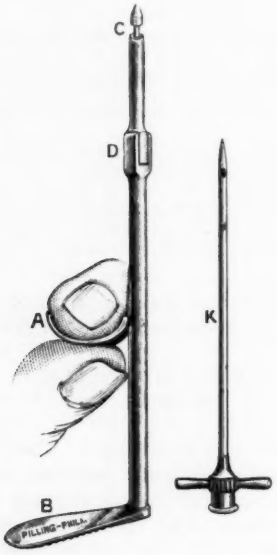
Second.—Where the antrum is repeatedly irrigated, the field of puncture becomes very sensitive, causing the patient to dread the irrigation.

Both of these conditions are eliminated by using a diagnostic needle with the opening in the side. After withdrawing the needle, the punch is introduced through the opening made by it and a hole is punched out in the naso-

*Presented to the Section on Eye, Ear, Nose and Throat, Southern Medical Association, Twenty-Second Annual Meeting, Asheville, North Carolina, November 12-15. 1928.

maxillary wall through which the needle can be pushed for later irrigations.

Technic.—The sub-turbinal region is cocainized by introducing a pledget of cotton (preferably on an applicator) wet with 10 per cent cocain solution. In ten or fifteen minutes the cotton is removed and the needle is introduced and pushed through the wall at an angle of about forty degrees with the nasal wall, and the eyelet of the needle is turned away from the septum. (This gives a whirlpool effect and washes the antrum effectively.)



After washing the antrum out with one pint of normal saline, if pus is found and more irrigations are necessary, the needle is withdrawn and the punch introduced through the needle opening until the septal wall closes about the neck of the punch. Then, holding the punch pistol-grip fashion, the cannula is pushed down, cutting a small ring of bone from the sinus wall. For later irrigations the needle can be introduced through this opening without difficulty and with very little inconvenience to the patient even without the use of cocain.

Shenandoah Life Building.

PHOPHYLAXIS OF RESPIRATORY DISEASES WITH VACCINES*

By James M. Adams, M.D.,
Baton Rouge, La.

Failure of proof of the etiology of colds, whether due to acute infection, climatic conditions, "acidosis" or other causes, leaves us without an acceptable weapon for their prevention. But, as they are the most common factor in the production of sickness disability, accounting for 35 to 40 per cent of all disabling illness, I think we are justified in proceeding along the lines of our personal theory, even though it may be necessary to resort to polypharmacy.

In an industrial plant employing 5,000 men, respiratory diseases caused 34 per cent of all cases of disabling illness and 35 per cent of all time lost from sickness disability during the past five years. Vaccine therapy seemed to us to offer the most promising means of reducing the respiratory disease incidence. We were able to secure from physicians numerous favorable opinions on the results to be expected, but were unable to find any satisfactory reports on their use.

This report is offered, not in an effort to prove the efficacy of vaccines, for the series and the period covered is too small to warrant any definite conclusions, but with the hope that it may stimulate further investigation.

We selected from our records the names of 136 employes, all males, all of whom had lost a considerable amount of time during the previous four years from respiratory diseases. All of these men were offered cold vaccine in preventive dosage. All were told frankly that we could promise nothing as to the results. Ninety-seven accepted and completed the treatment and 39 refused, 285 other employes requested and were given the treatment, making a total of 382 cases here reported.

The vaccines used were the stock preparations of two manufacturers designated as "A" and "B". "A" contained per c. c.—

Influenza bacillus (Pfeiffer)	400 million
Micrococcus catarrhalis	100 million
Pneumococcus (four types)	400 million
Streptococcus (Hemolytic and non hemolytic)	300 million

*Received for publication January 3, 1929.

"B" contained per c. c.—

Influenza bacillus	1000 million
Staphylococcus aureus	1000 million
Staphylococcus albus	1000 million
Streptococcus (hemolytic and non hemolytic)	1000 million
Pneumococcus (types I, II, III)	1000 million
Micrococcus catarrhalis	1000 million
Friedlander bacillus	1000 million

The dosage for the "A" vaccine was 0.5 c. c., 0.75 c. c., 1 c. c., and 1.5 c. c., at 3 to 4 day intervals. And for the "B" was 3 m., 6., 10 m., and 16 m., at the same intervals. Treatments were given in October and November, 1927. On April 1, 1928, all of the cases were asked the following questions:

(1) Do you think you were benefited by the treatment?

(2) Have you had as many colds as usual since taking the treatment?

(3) Have you had influenza or pneumonia since taking the treatment?

(4) Have you lost any time from respiratory diseases since taking the treatment?

Their sick records were checked to verify the answers to the last question. It is probable that before the expiration of the period covered, whatever immunity may have been acquired by many of the cases, had been lost.

Those answering yes to question 1 were:

"A"	64%
"B"	72%
Total	68%

Those answering no to question 2 were:

"A"	55%
"B"	66%
Total	62%

A number answered yes to question 1 and no to question 2, stating that they had as many colds as usual, but that they were of a milder type.

To question 3 the answers were:

	Had Influenza
"A"	35%
"B"	31%
Total	33%

The term "influenza" was used to cover severe colds with fever and toxic symptoms as well as influenza.

None had pneumonia. All time lost was due to influenza making the answers to question 4 the same as for question 3. The average amount of time lost per individual in the group was:

"A"	3.6 days
"B"	3.2 days
Total	3.4 days

The records of the 97 cases known to be unusually susceptible were compared with the 39 cases of equal susceptibility who refused the treatment. We found that in the vaccinated group 30 per cent lost time from respiratory disease for an average of 3.6 days per man, while in the control group 49 per cent lost time for an average of 6.3 days per man.

Twelve cases of pneumonia occurred among the non-vaccinated employes and none in the vaccinated group.

To ascertain whether the degree of reaction to the vaccine influenced the results, reactions were noted as negative when slight or absent and positive when moderate or severe. Fifteen per cent of those taking the "A" vaccine and 33 per cent of those taking the "B" had a positive reaction, a total of 24 per cent for the group. Sixty per cent of those with a positive reaction were improved while 70 per cent with a negative reaction showed improvement.

Before administering the vaccine, the nose and throat of each man was examined, the results being classified as acute rhinitis, chronic nasal disease, chronic tonsillar disease, chronic pharyngeal disease, and negative. The results in the cases showing diseased conditions were 69 per cent improved, and in the negative cases 68 per cent. The only significant variation noted was in the 55 cases with tonsillar disease which showed an improved rate of 62 per cent, six points below the average.

Treatment was begun but not completed in 47 cases. Results expressed in time lost from respiratory diseases were as follows:

	Per cent losing time
Taking one dose only	64%
Taking two doses only	26%
Taking three doses only	18%
Total	30%

As all individuals in this series were particularly susceptible to colds, it was felt that no conclusion would be warranted from comparing the respiratory disease incidence with that of the whole group of employes, many of whom have a high resistance to respiratory infections and never lose time from them. But it should be

stated as further influencing the results in this series, that the respiratory rate for all the employes was much higher during the six months period covered by this report than in the corresponding period of the preceding year. The rate for cases losing time from respiratory diseases during this period was 21 cases per 100 employes and for the corresponding period of the preceding year was 12 cases per 100.

We cannot be dogmatic in estimating the proper dose of vaccines. When we treat with antitoxin, we give a known number of antitoxic antibodies and with serums a known number of antibacterial antibodies, and we can give a much larger dose than may be necessary without fear of bad effects. But when we administer killed bacteria with the aim of manufacturing antibodies in the patient's blood, we cannot know what the reaction is going to be in each individual, even though we know the number of bacteria administered, and an overdose is productive of disagreeable results. It is probable that our results would be more uniform if we had some means of measuring the susceptibility of each individual and varied the dosage accordingly. Possibly this could be arrived at by grading the reaction to the initial dosage as is done in the use of pollen extracts and tuberculin. To do this a larger initial dose would have to be used, as in our series only 24 per cent reacted.

The duration of the immunity produced by an attack of respiratory disease apparently varies over a wide range and the minimum is probably no more than 30 or 40 days. A repetition of the maximum dose at intervals of 30 to 60 days throughout the season of the prevalence of colds therefore, would probably increase the percentage of favorable results.

SUMMARY

(1) Of 382 cases given preventive vaccine treatment for colds, 68 per cent were apparently benefited.

(2) In two groups of apparently equal susceptibility, 30 per cent of the vaccinated group lost time from respiratory disease while 49 per cent of the non-vaccinated lost time.

(3) The percentage of improved cases was ten points higher when there was no reaction to the vaccine. It is probable that the degree of natural immunity governed the extent of the reaction, and that the individuals with a negative reaction had a higher degree of immunity than those that reacted.

(4) Pathological conditions of the nose and throat did not affect the results except that the cases with tonsillar disease had a definitely lower rate of improved cases than the whole group.

(5) Cases taking less than the full number of doses showed a lost time rate equal to the whole group, the rate decreasing with the number of doses taken.

(6) Results were better with the "B" vaccine than with the "A".

(7) None of the vaccinated group had pneumonia.

SYMPOSIUM ON MALARIA

THE CONTROL OF MALARIA AS A PART OF FULL-TIME COUNTY HEALTH DEPARTMENT PROGRAM*

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In this day of health promotion all health workers are unquestionably of the opinion that the full-time county health department is the most logical source through which disease control on a large and efficient scale can be established and maintained. If this is the consensus of opinion, and I truly trust it is, then every effort should be made to bring all forces to bear in the establishing of a full-time county health department in each county of every state in the Union.

Under the control of the local full-time health department should, therefore, come the handling of every health problem in the territory, including malarial fever.

It is not believed that a worth-while malaria control program can be successfully carried on without full-time personnel, even with an organized county health department upon a permanent basis. Unless a well-trained, energetic, practical, tactful health officer directs and promotes the work assisted by an active, intelligent, interested sanitary inspector, with necessary cooperation from the state health department with a good division of malaria control, very little will be accomplished and the people will continue to be disappointed with the results obtained. An expert malaria epidemiologist with the assistance of one or more highly trained, experienced sanitary engineers seems necessary if anything approaching adequate state-wide supervision of malaria control activities in states having a real problem is to be honestly and intelligently undertaken.

We find doubting Thomases among health workers, physicians and laymen all over the Country for the reason that as a rule our past efforts have been spasmodic in nature with untrained, inappreciative and uninterested personnel. Another discouraging factor in our program has been that some of the engineers have thought that no one else could possibly know anything worth while about malaria control and some medical malaria epidemiologists have seemed to think that it was largely their peculiar problem and that the engineers were self-seeking, self-promoting usurpers in the field.

We all now recognize, or should recognize, that malaria control is a problem for cooperation and sustained effort and that foolish, petty jealousies should be forever banished. We must not forget to be practical as well as scientific.

It is recognized that where malaria is of sanitary importance it presents a large and difficult problem, and aid from the state health department is essential to determine the most effective program of control.

It is not profitable, nor is it wise, to make hasty surveys, depending on morbidity data and information picked up at random upon which to base control operations. Such methods result in a large waste of time and money and are certain to produce dissatisfaction among the local populace should inadequate control result therefrom, which can hardly otherwise be expected, and to place in jeopardy the security of the health unit.

We here face the fact of organization within the county, a factor to which perhaps too little attention has been given in the past, and the class of personnel comprising the force of the department. Unless the personnel has had the basic training and realizes the importance of practical application in the field, and unless there is an intimate knowledge of the people and their surrounding economic and social conditions, little if anything can be effectively done towards controlling malarial fever.

It is known that malaria is rarely, if ever, evenly distributed through a district in this Country. Even in extremely malarious sections "spots" are to be found where there is little or no malarial fever. The lack of proper knowledge of the problem, where it centers, and a definite and practical program for its control, will more than probably turn the supposed milestones of progress into tombstones of disaster

A quick and reliable guide or measurement of the problem is, therefore, essential. Districting of the county according to existing or supposed facts is a first consideration, to be followed by

*Chairman's Address, National Malaria Committee (Conference on Malaria), meeting conjointly with Southern Medical Association, Twenty-Second Annual Meeting, Asheville, North Carolina, November 12-15, 1928.

the measurement of the problem in the districts selected.

In some places physicians' morbidity reports are available, but rarely do these reports indicate the location of the patients, nor are all the existing cases of malaria seen by physicians. These reports furnish an indefinite guide at best.

To attempt the taking and examination of blood is a long, tedious and expensive procedure, the result being wholly in the hands of the examining technicians. This, with the lack of confidence in results obtained from examination of but the one blood specimen from the individual, makes the procedure questionable for use in quickly determining whether or not in a given area there exists a malaria problem of sufficient magnitude to spend time and money upon.

The examination of spleens is limited to a relative few, often perhaps to that group not so seriously affected as those of advanced ages or other races. This also requires considerable time, is not reasonably reliable, and is costly.

The indirect or proxy interview to obtain malaria histories affords only a questionable result, as does the direct interview when conducted by untrained personnel, or well-informed personnel lacking that understanding of the peculiarities or psychology of the classes of people to be dealt with.

For our problem in this Country we have no adequate measure, and too often we find prevailing the "riding of hobbies" both for measurement and control operations, and conflicting opinions prevailing when only the one subject is in question.

We must get down to the practical procedure, being as sure of our ground as present knowledge permits, and have the "It Can Be Done" confidence.

But in whom can confidence be placed other than in trained personnel, and by trained personnel is meant not the sixty-day sanitary inspector nor the new health officer or sanitary engineer or nurse, but that singular group of health workers who have not only the basic training but that indefinable public health viewpoint and a sufficient knowledge of economics and sociology peculiar to the territory involved.

Malaria control is a business undertaking and a well organized county health department is or should be a business institution.

This disease, as was said, is not evenly spread over any given county territory, and consequently sectional problems must be treated as existing evidence of malaria warrants, necessitating a flexible program with a basic standard.

Malaria control as part of a full-time county health department program is not only feasible but practical, and while this subject has been chosen for discussion, the writer is at a loss to comprehend why, so often, it is not considered, and why, when it presents an outstanding problem, health officers absolutely neglect to give it the consideration it warrants. Gradually the standard of health personnel is being improved. With the type of workers now entering the field rests not only the practical control of malaria, but the handling of other problems as well.

Time is of extreme value to all health officers, and to determine the extent of a malaria problem time is an element of importance.

The surest, most practical, the least costly and the most reliable quick method for determining whether or not a malaria problem of importance exists within a given area is the taking of direct histories. Only one proviso is made to this statement, which is that the worker know his subject as well as his subjects, and be sufficiently interested to withstand the monotonous grind associated with the work.

After establishing the fact that problems do exist in various localities, the dealing with the individuals by taking blood specimens to foster treatment can be undertaken.

These statements are made advisedly, as only recently a history index of 402 persons in a certain section of Mississippi gave a rate of 17.2, while the blood index gave a positive rate of 17.2. While exact agreement of the two rates will seldom occur, yet the evidence is there and past experience has demonstrated the reliability of the measure.

The difference between malaria control and malaria investigation must be recognized, as must anopheline control versus general mosquito control, and it must be continually borne in mind that the result is what is desired, even though several years must be spent even to pave the way.

The results to be achieved probably never will be spectacular. It may require many months of effort to determine the distribution and extent of malaria in a county. After this determination, only a very few foci may be brought entirely under control during the next one or two years, but if the program is followed consistently and consecutively over a period of years, as a part of the general public health program of the county health department, it is

believed that the same good results will be achieved as in typhoid control, the consolidation of rural schools, construction of permanent public highways, etc., bearing in mind that it is only over a period of years and by being everlastingly at it that satisfactory progress is made along all lines of human endeavor.

Control measures should not and cannot be discussed here, as they will vary according to the problems presented and the advisability of their application, and are preferably worked in combination.

To prevent new cases and cure existing cases is the object.

First must come educational work; for to act intelligently one must understand.

Permanent eradication is to be desired, which means anopheles control. This is not always practical and leads to the application of such methods as will reasonably solve the problem.

The individual, acting as an individual, or a plantation owner or head of a large concern employing labor in a malarious section, is as much responsible for the control of malarial fever as for typhoid, diphtheria, smallpox, or any other communicable disease, and therewith rests the practicability of malaria control as part of the county health department program.

A RESUME OF STUDIES UPON PLASMOCHIN*

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At the 1927 meeting of this Conference I reported my experience with plasmochin in the treatment of 108 cases of malarial fever. Owing to the short time intervening between the conclusion of the work and the presentation of the study, the material had not been fully digested and many important observations had not been brought out.

It is the purpose of this contribution to make further observations upon these cases as well as upon 27 cases observed in 1928, and present some conclusions as to the advantages and disadvantages of plasmochin as a remedy for malaria. It was found and reported that plasmochin was a satisfactory remedy for the treatment of infections with *Plasmodium vivax*, but that it could not be relied upon for the treatment of estivo-autumnal malaria. We found that gametes of *P. vivax* disintegrated and disappeared at about the same rate as the schizonts. In the case of *P. falciparum* we noted disappointing results in the control of the vegetative phase, but a very decided effect upon the gametes, which, however, was less pronounced than upon *P. vivax*.

To recapitulate the findings in the 1927 series: in the cases of tertian malaria the maximum time recorded for the disappearance was six days for schizonts and five days for gametes. In the majority of cases the blood was free from both after four days.

In the cases of estivo-autumnal infections, schizonts persisted as long as eight days with plain plasmochin, the gametes persisting in one case eight days with plain plasmochin plus quinin and nine days with plasmochin compound. None of the 1928 series exceeded these limits.

As to the contribution of quinin to these results some comment will be presented further on.

These findings are in entire accord with those appearing in many reports in the *Arch. f. Schiffs. u. Tropen-Hygiene* and elsewhere, which can be studied in abstracts appearing in *Tropical Diseases Bulletin*, 1925 *et seq.*

Considerable difference of opinion exists as to what may be considered a safe dose of plasmochin under all circumstances.

To make clear the conditions under which cyanosis has appeared in our cases in 1927 as well as in 1928, the mode and frequency of administration must be considered. Although some of our cases were treated with plasmochin alone, in others quinin was added later or combined in the beginning. In the tables presented last year[1] patients receiving both drugs apparently responded more slowly that when either was given alone. These patients did not get quinin until it was deemed necessary to add it because of the persistence of the fever or the parasites.

When treated with plasmochin alone plasmodia persisted longer than the fever. In the beginning there is a definite provocative effect so that parasites, and especially gametes, would be more abundant on the second day, the drug acting like small doses of quinin in this respect. It must be understood that the stage of development of the parasites was taken into consideration.

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*Read before National Malaria Committee (Conference on Malaria), meeting conjointly with Southern Medical Association, Twenty-Second Annual Meeting, Asheville, North Carolina, November 12-15, 1928.

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Taking advantage of this fact, we adopted the practice of beginning treatment with plain plasmochin if the clinical diagnosis was reasonably certain and checking this with a blood examination later. This procedure gave us an early start on the gametes, as patients frequently sign out in less than five days.

If the blood showed *P. falciparum* or if the fever persisted for three days, we added quinin sulphate (10 gr. t. i. d.). There is quite a factor of error in the ring stage or in double infections which is not recognized until the complete fever curve has been recorded or the drug has failed. Sometimes there was a relapse in a day or two and typical rings and crescents were seen.

Plasmochin can, indeed, be relied upon for a correct differential diagnosis.

Several deaths from plasmochin having been reported, I reviewed the histories of the patients receiving plasmochin treatment in my service.

Of these 135 patients, 108 were treated in 1927. Seven of these developed toxic symptoms of varying degrees. In this series the maximum daily dose was five tablets of plain plasmochin, given singly, after food, equivalent to 0.1 gm.

In the 1927 series of 108 patients we had

1 case of tertian, after 38 tablets, epigastric burning.

1 case of tertian, after 28 tablets, cyanosis, lasting 48 hours.

1 case of tertian, after 22 tablets, cyanosis lasting three days.

1 case of tertian, after 27 tablets, vomiting and severe epigastric pains.

1 case of estivo-autumnal, after 30 tablets, severe cyanosis, depression, lasting four days, relapsed later.

1 case of estivo-autumnal, after 31 pills of plasmochin comp. pyrosis.

1 case of tertian, after 26 tablets, marked cyanosis.

In the series of twenty-seven cases treated in 1928 the tablets (0.02) were given two at a dose three times a day. Since we were on the lookout for toxic symptoms, this seemed to be a simpler technic. Toxic symptoms resulted in five cases, or 14.8 per cent. This mode of administration is unsatisfactory.

The series comprised three cases of slight cyanosis, following 36, 22, and 14 tablets of plain plasmochin, one case of marked cyanosis following 24 tablets and one of severe cyanosis, lasting six days, associated with vomiting, which lasted three days, following 20 tablets. There were no toxic symptoms in others, taking as much as 36, 38 and 42 tablets, respectively.

None of the patients receiving quinin in addition to plasmochin showed any cyanosis, although one of them had received fifty-two tablets, or a total of 1.4 grams. One of the 1927 series, however, had also had some quinin.

Although the symptoms in most of these cases were slight and transient, it is apparent that even five tablets daily given singly constitute too large a daily dose for general practice. This will be discussed later.

On account of many inquiries since the publication of my last paper some explanatory statements seem to be in order.

Many physicians appear to believe that plasmochin is in every way superior to quinin and have wanted to prescribe it in pernicious malaria. Some have disregarded the precautions insisted upon in the literature, and have observed severe toxic symptoms.

The following points are emphasized:

Plasmochin is useful and quite equal to quinin in ordinary doses in benign malaria. It is the only remedy that definitely affects gametes.

Plasmochin cannot and must not be relied upon in the treatment of estivo-autumnal malaria. Persistence in experimenting with plasmochin in estivo-autumnal malaria will result in serious disappointment and possibly some deaths from pernicious malaria. If crescents are present it should be given in conjunction with the quinin.

Cases of malaria occurring prior to July 1 (in our latitude) are very rarely of the estivo-autumnal variety.

All cases of frank intermittents with short paroxysms may be treated with plasmochin.

Plasmochin produces none of the objectionable symptoms of cinchonism and should be preferred in cases of quinin idiosyncrasy if the blood unequivocally shows only tertian parasites. These patients were delighted at the total absence of the usual symptoms of cinchonism.

Regardless of whether quinin is needed for the control of the fever, only plasmochin can affect gametes and thus prevent transmission.

On account of the very great variation of susceptibility, plasmochin prescriptions should bear the legend: "Nil repetantur," in large type or red ink, and patients should remain under daily observation. If this cannot be done, the remedy should not be prescribed.

How can plasmochin be used in public health practice?

Fischer and Weise[2] emphasize the toxicity of plain plasmochin and recommend that only the compound be given in doses of not more than

three dragees per day. This dose is quite insufficient for the cure of the fever because these contain only 0.01 gram of plasmochin, but Fischer and Weise insist that quinin should be given in addition to prevent the reappearance of gametes.

I think this is excessive caution, admitting that several deaths have been reported following persistence in the exhibition of large doses.

Brosius,[3] who has been the largest user of plasmochin, employs only the compound pill, adding more quinin if the symptoms do not come under control promptly. He says he has never seen any toxic symptoms from six of these daily, or two pills three times a day. He agrees with many other observers that quinin is synergistic as a plasmodicide, but inhibits the toxic effects of the drug.

It has been abundantly shown by others as well as in our service last year, and with 17 cases treated exclusively with plasmochin this year, that for the benign malarias we have a complete substitute for quinin. We have the additional even more conclusive evidence that gametes of both species rarely resist plasmochin longer than five days if it is given in full (5 tablets) doses, that is, 0.1 gm. daily in single doses of 0.02 gm.

Unfortunately, our relapse experience has not been bettered.

Just to show how little we have advanced in eighty years in the methods of treating malaria with quinin and how little can be expected from it for the eradication of gametes, I shall quote some old malaria literature:

Sobernheim (1840), quoting Griesinger, writes:[4]

"The total dose of quinin to be administered in quotidian and tertian fevers is, according to Gittermann's results, compiled from several thousands of observations, 12 to 16 gr. (0.72 to 0.96 gm.), but in quartan fever 20 gr. (1.2 gm.)."

Coming down to the period following Laveran's discovery, we read:

"The statements of Golgi (1884) regarding the effect of quinin in cases of fever accompanied with crescent forms, the developmental cycle of which was not yet known to him, are much less distinct. He emphasizes that these forms, similar to the lasting forms of schizonts, are almost insusceptible to the action of the ordinary agents. The infection had not disappeared in many cases after 10 to 12 grams of quinin given in the course of eight to ten days, although the attacks of fever failed to appear."

Regarding the flagellated forms, which in his time were not identified with crescents, Golgi was not able to determine an influence of quinin either upon the occurrence of these forms or upon the manner in which they presented themselves or upon their movements.

Guido Baccelli injected neutral solutions of quinin hydrochlorate (quinin hydrochlorate 1.0, sodium chlorid 0.75, distilled water 10.0) into the veins of numerous malaria patients, especially in severe pernicious forms of the disease in which the other modes of absorption had proven to be insufficient, and he found that doses of 10 to 30 centigrams were entirely insufficient, that doses of 40 to 60 centigrams showed a better effect, which were not completely satisfactory; that doses of one gram, however, which corresponded about to the concentration of one to 5,000 determined as fatal to infusoria by Binz, had infallible therapeutic effect.

The pigmented and crescent-shaped varieties of Laveran remained visible for several days after the intravenous introduction of the quinin and after the disapparance of the fever. . . . . the developed forms, the semilunar and pigmented ones, occurred also during the afebrile intermission in such a manner that the condition of the blood in these various forms proved to be identical in patients suffering from quinin poisoning and in those that were not affected by the latter.

Mannaberg,[6] 1892, after describing changes in fresh blood at different stages after the administration of quinin, says:

"One form of malarial parasite is totally resistant to quinin, namely, the crescent.

"It is the unanimous statement of all observers that crescents remain unchanged after the most persistent administration of quinin, and that the therapy is incapable of playing even a prophylactic role, in that relapses occur whether or not quinin is exhibited in the apyretic interval."

Numerous other observations in accord with what has been quoted can be found in the voluminous classical literature of the period and not a single authority is in conflict with them.[7]

The very extensive literature upon the war experiences with malaria has not modified these observations with respect to the effect of quinin upon crescents or for the prevention of relapses.

It is hardly necessary to allude to the studies of Yorke and McFie[8] and those of James and Shute[9] with respect to the prophylactic value of quinin. Sir Malcolm Watson, on the ground of his very extensive experience in the Federated Malay states, says that where the blood index is 50 per cent, quinin is not effective.

Just what the systematic use of plasmochin would accomplish in the way of temporarily preventing transmission from convalescents can be determined only by its extensive use by many field workers through several seasons.

For this purpose the compound pill, containing 0.01 gram plasmochin and 0.125 gram quinin sulphate, should be given according to the directions supplied by the manufacturers. For relapsing patients this dose must be reinforced by concurrent doses of quinin, not less than 15 grams per day, in the same interrupted manner.

Manson-Bahr[10] proposes to give plasmochin compound for a full week in three courses with

five-day intervals. This permits complete elimination of the drug between courses. His impression is that relapses have been greatly diminished.

The German plan of five-day treatments with only two-day intervals may not be entirely safe in general practice, if full doses are given.

We may then consider four lines of treatment:

(1) The one employed by the author: begin with plain plasmochin, one tablet five times a day, after food, adding quinin as outlined in this paper, but not in solution. Suspend plasmochin after five days or at the appearance of cyanosis. Plasmochin compound, one tablet three times a day, may be safely substituted, but the treatment must continue longer before crescents will be found absent from thick films. Repeat plasmochin if the crescents persist.

This treatment requires two daily visits or an alert house staff. It insures prompt destruction of gametes. Follow-up treatment is necessary to prevent relapses.

(2) The ambulant plan sponsored by the Medical Service of the United Fruit Company: the dose is two tablets of plasmochin compound three times a day together with full doses of quinin sulphate for five days, then report for blood examination. Ninety-six per cent of their cases were free from crescents. Follow-up treatment is given according to indications.

(3) For public health survey work, according to Fischer and Weise: three tablets plasmochin compound with full doses of quinin are given for a week. After an interval of two to five days the course is repeated. Quinin is given to prevent relapses.

(4) Manson-Bahr's treatment was quoted above.

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DISCUSSION (*Abstract*)

Dr. I. J. Kligler, New York, N. Y.—After the first three to five days our chronic patients refused to take plasmochin because it had a provocative effect upon their symptoms. There was no cyanosis, but there was, by blood examination, a definite stimulation of the malaria parasites in the patient, and in one case hemoglobinuria resulted. It should be recognized, therefore, that the drug has a provocative effect, particularly in malignant malaria.

For the time being, one ought to limit the use of plasmochin to treatment under the control of a physician and not use it wholesale as a prophylactic.

Dr. R. L. Miller, Waynesboro, Ga.—I have tried plasmochin in 163 cases and am most favorably impressed with the results.

My plan has been to break up the acute attack with quinin and then put the patient on plasmochin compound. In this way I have reduced decidedly the number of relapses. I used it in several families where one member of the family was the gametocyte carrier, with no special effort to protect the other members of the family, with no other development of malaria in these families. I have also used it in plantation work among negroes with happy results.

Most of my laboratory work was unsatisfactory, but of three cases in which gametes were found they disappeared in five days in one case, six days in another and eight days in the other.

I have used only the plasmochin compound.

Dr. M. A. Barber, Greenwood, Miss.—I will describe briefly our work in Central America with plasmochin.

We made blood parasite surveys of groups of West Indian negroes living on the plantations of the United Fruit Company, Panama Division. Positives were brought to the Company hospital, where they were given a dose of plasmochin plus quinin by Dr. Otto Brosius, Superintendent of the Medical Department, Panama Division. They were given a supply of both drugs to take home with them.

At the end of two days they returned for a further treatment and supply, making in all three trips at intervals of two days. At the end of the week we examined their blood to determine the percentage of positives.

We also examined treated groups at various intervals after treatment to determine the percentage of relapses.

We fed *Anopheles albimanus* on the blood of certain heavy gametocyte carriers after a short treatment with plasmochin plus quinin. It appeared that plasmochin may render gametocytes non-viable while they are still plentiful in the peripheral blood.

The series of experiments on gametocyte carriers was a short one, and we plan to continue this work in Panama during the coming winter. The purpose of the work is to determine more closely the minimum dose of plasmochin which will destroy gametocytes or render them non-viable. Such work may help to lay the basis for a wider use of the drug.

Our results of last winter are published in the Sixteenth Annual Report of the Medical Department of the United Fruit Company.

SODIUM CACODYLATE IN THE TREATMENT OF PERNICIOUS MALARIA*†

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Those of us who live in a highly malarious country or near enough to it to have the severer forms of malaria sent into our hospitals, are frequently confronted with one of the real emergencies of the practice of internal medicine: the comatose, algid or asthenic type of estivo-autumnal fever.

The City of Augusta lies directly upon the fall-line, above it impounded waters, below it cypress river-swamps which stretch, unbroken, to the sea. So that each year there come into our hospital wards, in diminishing numbers happily, many cases of severe malarial infection. These cases are always desperately sick, and the problem of what is to be done for them in the first twelve or twenty-four hours is urgently pressing. There is no time to be lost in the administration of drugs by mouth which may or may not be absorbed, no time for a slow or cumulative drug effect to manifest itself. Emergency measures only will meet the situation.

Clinical experience taught our forbears the inefficiency of quinin medication alone in these cases, and the literature of thirty or forty years ago is replete with articles and controversies anent its value. With the subsequent development of intramuscular and intravenous quinin medication it was hoped that the objections advanced to quinin *per ore* would promptly disappear.

This, however, did not prove to be the case, quinin administered intramuscularly being attended by sterile but very painful and slow-healing sloughs, quinin intravenously by gravely toxic symptoms, collapse and death, the sum total of which is constantly increasing as the case reports accumulate.

Having passed through several most unpleasant quinin tragedies, the writer, stimulated by an article by Laumonier[1] in 1906, began experimentally to use sodium cacodylate in the severer and more exigent types of malaria. At first our medication was wary and tentative, in doses of 1.5 to 2 grains intramuscularly two or three times daily with apparently beneficial results. With the rapidly increasing popularity of intravenous medication and the appearance on the market of the product in sterile ampoules, a shift was made to the intravenous route, which has been utilized in increasing doses for more than ten years. The drug was used primarily as a substitute for quinin in cases where quinin was deemed to be contraindicated by reason of the slowness of its action by mouth or its danger intravenously. As soon as possible the arsenic was discontinued and routine quinin treatment by mouth resumed.

It was considered of sufficient interest to treat a considerable number of cases with sodium cacodylate alone in order that some estimate of its action unaided by quinin might be obtained.

Increasing familiarity with the harmlessness of the drug led us, by slow degrees, to increase our doses to a point where now, in pernicious cases, we administer four doses of 7.5 grains each at six-hour intervals until the patient has emerged from coma or in other ways shows such improvement that the routine quinin therapy may be resumed.

In the purely experimental cases, the dosage was halved as soon as the parasites disappeared from the peripheral blood, which usually occurred on the third or fourth day, and this dosage was continued for fourteen days.

There seemed, to those of us who followed these cases, that there was no greater tendency to relapse or recrudescence after the arsenic was discontinued than is usual after the administration of quinin for a similar period.

There have been very few reactions following this dosage which were worthy of note or comment: occasional nausea and vomiting, colicky pains, the persistent ineradicable garlicky odor of the breath and a "brassy" taste being the chief symptoms of which the patients complain.

In no case have we had any skin rashes or dermatitides such as are frequent after arsphenamine or stovarsol.

The following brief histories from the record of cases studied in the University Hospital are presented for your consideration:

Case 1.—Ida L., a Jewish housewife, age 23, was admitted September 24, 1920. She had become ill four days before admission with chill, high fever, intense nausea and vomiting. She was unable to retain any nourishment and very little water. Just before admission her temperature was 97° F. On admission it was 100° F., rising shortly to 104°. Blood showed a very heavy infestation with estivo-autumnal ring forms.

Sodium cacodylate, 5 grains, was administered intravenously every six hours for three days, after which the dose was halved.

*Read in Section on Medicine, Southern Medical Association, Twenty-Second Annual Meeting, Asheville, North Carolina, November 12-15, 1928.

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Paroxsyms recurred September 27, her temperature reaching 103° F. There were paroxsyms on September 29 and October 1, with a maximum temperature of 102° F.

The blood was negative September 28, the fourth day after beginning treatment, and it remained so thereafter. No quinin was used.

Case 2.—Thomas D., a white farmer, age 28, was admitted August 20, 1919, with a history of pronounced idiosyncrasy to quinin. He had been ill for three weeks before admission. He was having daily chills with high temperature, anorexia, emaciation and dehydration. Temperature on admission was 105° F. and he was semi-comatose. Pulse was 140 and respirations 20.

Abundant estivo-autumnal ring forms were found.

Sodium cacodylate, 5 grains, was administered every six hours. His blood remained positive through August 21 and was negative thereafter (two days positive).

On August 21 his temperature rose to 104° in the afternoon with a morning decline to 99°. For three days an identical rise occurred, after which it declined to normal and remained there throughout his convalescence.

The dosage was halved on the fifth day. No quinin was administered and there was no recurrence.

Case 3.—R. A. T., a white insurance agent, age 50, was admitted August 2, 1922, in coma, with temperature of 105.4°, pulse 130, and respirations 28. Estivo-autumnal rings were found.

Sodium cacodylate, 7 grains, every four hours for three doses was given. Next day the patient was mentally clear. Sodium cacodylate was given at 5:00 and 8:00 p. m. His maximum temperature the second day was 102°. Quinin treatment was instituted the third day. The blood was negative. He had an uneventful recovery.

Case 4.—S. P., a male, rabbi, age 59, was admitted November 15, 1920. He had been ill for six days before admission with chills and fever recurring daily. His skin was cold and clammy; expression pinched; pulse small and wiry; temperature 97° F., pulse 120, and respirations 26. The blood showed a heavy infestation of estivo-autumnal ring forms.

Sodium cacodylate, 5 grains, was administered every six hours for three days, halved daily for the remainder of his stay in the Hospital.

Paroxysms ceased November 21 and the temperature remained normal. No quinin was administered throughout this case, and there was no recurrence.

Case 5.—P. L., a well nourished and developed white farmer, aged 39, was admitted September 20, 1928, a stretcher case, comatose. His temperature was 106.25, blood pressure 100/60, and pulse 112.

Sodium cacodylate, 15 grains, was given September 21 and 22. He regained consciousness on September 21 and gave a history of previous good health to September 14, on which day he developed a chill and high temperature.

Paroxysms were repeated September 16 and 18.

Quinin therapy was resumed September 23.

The blood was negative for estivo-autumnal parasites from September 24 to 27. Gametocytes were present September 28.

Case 6.—This experimental case was seen July 7, 1919. A negro man, a speak-easy bartender, aged 42, had a history of a daily chill and high temperature for five days. The temperature was 105.35, pulse 120, full and bounding, and he had severe head and backache.

The blood showed a heavy infection with two broods of tertian parasites.

Sodium cacodylate, 7.5 grains, was administered every six hours for two days. There was a paroxysm on July 8 and an abortive paroxysm on July 9. The temperature was normal thereafter. The blood was negative July 10 and medication was discontinued. He had a recurrence July 14, the day after treatment was discontinued.

These histories are presented as being typical of a series running well into the hundreds, and are condensed to show only one salient point, the reaction of the individual to the particular medication under discussion.

Year after year our students and our house staff men, after the conclusion of their terms of service in the University, have returned to the hinterland to engage in the practice of their profession, and from them there have come continuously reports that they have been carrying out the methods of treatment outlined above with satisfactory results.

It has seemed that the action of this particular drug is somewhat less efficient in benign tertian forms of malaria than in the estivo-autumnal cases, there being in a number of experimental cases of tertian fever an apparently greater tendency to recrudescence or relapse.

I trust that it will not be assumed that I am advocating the abolition of quinin therapy, but in view of the experience which I have had, the definite conclusion has been reached that we have in sodium cacodylate an agent which is capable of at least temporarily arresting the progress of the disease; and that in cases where, for purposes of observation, no quinin was used, a permanent cure seemed to have been effected.

We have come to believe that in small doses we are able to induce provocatory stimulation somewhat similar to that occurring in spirochetal infections. In several cases where the question of the diagnosis of malaria was pressing and where the most careful repeated examinations of films and thick smears failed to reveal the presence of parasites, the administration of five to seven grains of cacodylate followed by examination of the blood at two-hour intervals for ten hours revealed the presence of sexual forms in the peripheral blood. In several other cases, afebrile but presenting symptoms suggestive of chronic malaria, the injection of a provocative dose as above described was followed by a rise of temperature, but without demonstrable parasites in the blood stream, which rise of temperature would follow several successive in-

jections after intervals of two or three days; and while it is not justifiable to draw any conclusions from this phenomenon, it is to our minds at least sufficiently suggestive to induce us to offer it here for discussion and for subsequent confirmation or refutation by interested observers.

One is impelled to wonder if there be not some peculiar inflexibility about the "medical mind." If we could for a little while remove from our consciousness our belief in the specificity of quinin, we could perhaps evaluate more fairly the use of arsenic in the malarial fevers.

Certainly when in experimental therapy we seek an etiotropic agent for use in protozoan infections, we turn almost uniformly to some of the pentavalent forms of arsenic, and yet in this particular protozoan infection we treat a valuable therapeutic agent with less consideration than is normally shown to be a backward stepchild.

The very history of medicine teaches us that arsenic and its derivatives were believed to be useful in paludism from time immemorial; nay more, were the acknowledged specific until the time when the Jesuit Fathers brought back the first cinchona bark from Peru, so that in continuing over a considerable period of years a study of the effect of arsenic in the severer forms of malaria, the writer can lay no claim to originality, but only to the persistent unremitting attention to the action of this particular drug. It must not be understood that the use of arsenic in this form could be expected to replace many other therapeutic measures which are indicated, its role being that of a safe, nonirritating and dependable etiotropic agent for use in the frequent emergencies which arise in the treatment of malaria.

(1) It is the belief of the writer that sodium cacodylate in proper dosage will clear the blood stream of malarial parasites and cause a cessation of all symptoms.

(2) A sufficient number of cases has been studied in which arsenic alone was used to convince the writer that it will by itself permanently cure malarial fever.

(3) It is not germane to this discussion whether it acts directly upon the parasite or merely by stimulating phagocytosis.

(4) To attain the results described, 20 to 30 grains should be administered in each twenty-four hours.

(5) It is less toxic when administered intravenously than is quinin, is more efficient than arsphenamine and less apt to produce a rash than is stovarsol.

(6) It is becoming increasingly apparent that quinin therapy alone is not the solution of the cure of malaria and a further study of the action of the arsenicals, together with that of iron, must be made before the problems which confront us will be solved.

DISCUSSION (*Abstract*)

Dr. J. B. McElroy, Memphis, Tenn.—I believe that there is only one use of intravenous injection of quinin and that is in the comatose cases. I have seen no distress or disagreeable results from it, but that is possibly because I did not use it except when it was very strongly indicated. I believe it will be advantageous to us to follow Dr. Murphey's suggestion.

Dr. S. Chaille Jamison, New Orleans, La.—I have had no experience with the use of sodium cacodylate intravenously in the treatment of acute malaria. I did advocate many years ago, in a paper published in the SOUTHERN MEDICAL JOURNAL, the use of cacodylate of soda in cases of malaria that had developed very severe anemia and I attributed much of its value merely to its effect upon the anemia.

I have had the experience in the negro wards of the Charity Hospital of seeing patients who were under intravenous arsphenamin treatment for syphilis actually develop chills and fever. That shocked my faith in the power of the arsenicals in the treatment of the disease very seriously, I must confess.

We have used quinin intravenously since 1910 at the Charity Hospital. It is now becoming a rare thing in New Orleans to use this treatment. We teach that quinin is not to be used intravenously if the patient can take it by mouth and that so far as any of us who are connected with the staff knows, it has no value intramuscularly. When the patient becomes comatose he has to be given the quinin intravenously, never more than 15 grains to the dose and never stronger than a 1 per cent solution either in freshly distilled water or saline. We have had no accident that we can attribute to the quinin. I do not believe that quinin is at all dangerous in the treatment of pernicious malaria.

If, while you are giving a certain treatment, plasmodia disappear from the blood, it is not proof that the disease is cured. Any of us who has lived in a malarial country have had the very bitter experience of seeing a patient die from malarial fever which was not demonstrated until autopsy, the blood smears having been negative. We have always felt that if a patient had malarial fever and was in coma we could usually find enormous numbers of plasmodia in the blood. Dr. Castellani told me at one time that it was not at all necessary for plasmodia to be demonstrated in the blood stream, even if the patient were comatose from malaria. I confess that was new to me.

We now have in New Orleans scarcely enough cases of malaria to demonstrate to our classes.

Dr. R. L. Miller, Waynesboro, Ga.—I have noticed that those patients who pass the time for the next exacerbation without coming out of coma almost invariably die. This shows the utter futility of temporizing with any drug that is slow of action or dependent

upon a cumulative effect. In the commercial world there is a phase "Time is the essence of the contract." So in dealing with the comatose form of malaria time is of the utmost importance. In fact, it is the determining factor. We must select a drug whose therapeutic effect can be rapidly obtained without necessitating a long wait upon gastric absorption.

In mercury we have a specific possibly more effective in syphilis than quinin is in malaria. Likewise in yaws, trypanosomiasis and the other protozoan infections we turn immediately to some form of the arsenicals. If it is efficient in these protozoan infections one is certainly within the bounds of good therapy in using it in malaria.

I do not use quinin intravenously for the reasons outlined by Dr. Murphey. I have been using cacodylate of soda for the past six or seven years with the same happy results which Dr. Murphey has obtained.

Dr. William Krauss, Memphis, Tenn.—I have had no experience with sodium cacodylate in this dosage in the treatment of any disease. In the treatment of estivo-autumnal fever I have utterly failed with all remedies other than quinin. I think the German writers, all of the British writers and, in fact, in all the Tropics the same results have been reported. We may say in a general way that there is no other disease except syphilis in which every promising remedy has been completely tried out. In the tertian malarias all arsenicals are rather inferior to quinin for the suppression of the fever, but they are not without value. Of course, Dr. Murphey has achieved brilliant results and he has used a drug that none of us would have attempted to use in such large doses, certainly not intravenously. I cannot make myself feel that it would be entirely safe. It may be that the history of the treatment of pernicious malaria will have to be rewritten in the face of this very bold therapy that Dr. Murphey has undertaken, but at present I still hold with the other malaria workers that the arsenicals are vastly inferior to quinin in the treatment of malaria, arsphenamin, stovarsol and sodium cacodylate not excepted.

Dr. J. S. McLester, Birmingham, Ala.—I think arsenic is of limited value in the treatment of malaria. We should be careful in drawing final conclusions from a small percentage of cases, particularly as the patient with malaria will often get better if he is merely put to bed.

The combined experience of the past has indicated that no drug is comparable to quinin for the treatment of malaria. As for the preparations of arsenic used, I cannot help but feel that Fowler's solution given by mouth is about as good as cacodylate of soda. There is something impressive in putting a drug in a patient's veins and we often feel that we are thereby employing energetic measures, but it should be borne in mind that great harm can be done by injudicious intravenous therapy.

Dr. V. P. Sydenstricker, Augusta, Ga.—My reaction to cacodylate of soda was at first just like that of the other speakers. It seemed rather useless and perhaps irrational in the face of the widespread efforts at arsenical therapy. Going at the thing with an open mind, or rather standing on the side line with an open mind for about five years and then having used it to a very considerable extent for the past four years, I am convinced that not for the routine treatment of malaria, but for the treatment of the comatose patient who is vomiting and who is dehydrated and cannot absorb quinin by mouth and will not stand probably as much as 5 grains of quinin intravenously, cacodylate is safe and is life-saving. It is not a substitute for quinin and Dr. Murphey does not intend to imply that, but a patient who has been in coma for six or eight hours, or who falls on the street in malarial coma, reacts nicely to cacodylate, and I think if it is used within the first eighteen or twenty-four hours he will get well. Of course, as soon as the immediate symptoms subside regular quinin therapy is instituted. I have watched Dr. Murphey's work with much interest. I came to it with not only skepticism but rather an unpleasant reaction, but I have absolutely changed my mind.

Dr. Cabot Lull, Birmingham, Ala.—I wish to ask Dr. Murphey what dilution of quinin was used? A case that I saw received 15 grains of fairly dilute quinin intravenously. The patient was *in extremis* and after forty-eight hours died. I have always felt that the death was due to the type of the infection and not to the quinin, since it occurred long after the injection.

Dr. M. L. Graves, Houston, Tex.—In the fall of 1915 I had the opportunity to see many cases of malaria that we thought had been brought to Galveston on steamers from Mexico. These were tertian and estivo-autumnal infections. I gave them rather large injections of sodium cacodylate in 3, 5 and 7.5 grain doses. After considerable experience with it I decided that it was not of sufficient value to continue its application in estivo-autumnal cases.

In one very serious case of estivo-autumnal malaria I believe the patient's life was saved by a citrated blood transfusion, 600 c. c. with 15 grains of quinin sulphate in the transfused blood.

Dr. Murphey (closing).—We have much malaria in our section of the world and to me it has always been a particularly fascinating subject of study.

The dosage which we have used, I will admit, seems incredibly large, but do not for a moment imagine that when I started this particular line of investigation my efforts were not as I have described them, wary and tentative. There seemed to be just enough encouragement in the matter to go ahead, follow it further and see what results might be obtained. I do not believe that I am taking the attitude of a Don Quixote, tilting at the windmills of quinin therapy. I am not bringing to you the untried enthusiasm of youth, but the seasoned experience of twenty years. Because I realized that this particular problem would need observation over a long period, and accumulation of case history upon case history before any sort of conclusion could be accepted, I have withheld anything but discursory papers until now because the twenty years were needed before I could believe that I was justified in my opinion.

The quinin fatalities mentioned occurred in the wards of the Hospital when I was in charge. They did not occur under my hands, but my house staff was using the ordinary ampoule as it comes from the manufacturing chemist. The last of these three fatalities occurred ten years ago. Death was practically instantaneous and certainly attributable to quinin in the opinion of all of us.

DIFFERENCES IN THE HABITS OF ANOPHELINES WHICH TRANSMIT MALARIA IN AMERICA, IN EUROPE AND IN THE FAR EAST*

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Doctor Darling, whose personality and fund of experience we miss with poignant regret on such an occasion as this, used to say that to become a good malariologist one had to learn to think like a mosquito. Each malaria worker, of course, devotes himself to the psychoanalysis of the particular species with which he has to deal and constructs his program accordingly. He does not often have the opportunity to work in a number of different regions of the world, and so he thinks of malaria constantly in terms of his own particular problem. He falls into a sort of provincialism as necessary and pardonable as that of the poet who sang "What is so rare as a day in June?," forgetting for the moment that it was midwinter below the equator.

But is is now getting to be known that all anophelines everywhere do not think alike by any means, and the specialist in one mosquito must be on his guard against what Darwin called the most hazardous of human tendencies, the drawing of general conclusions from limited experience. Scientific literature now reaches an international audience and what is said here today with local conditions in mind will be read tomorrow in Italy, India, and Peking. Our soundest knowledge, then, may lead us astray if we enter unwarily into discussions with foreign workers, or recklessly publish unqualified generalizations and theories with regard to mosquito behavior and control, or, worst of all, if we reason by analogy and take the lessons we have learned through hard work or bitter experience in one region and attempt without preliminary study to apply them in another. This has been done, of course, time after time before the medical entomologist was developed and could obtain the ear of the responsible authorities. For if failure or disaster occurred in these cases, it was almost always due to the unexpected behavior of some Anopheles mosquito.

One of the most famous examples may be found in the story of the sanitation of Kuala Lumpur, capital of the Federated Malay States. After long and painful experience, rubber planters on the coastal plains had found that clearing the jungle for half a mile round about the laborers' quarters protected them from malaria, since *A. umbrosus,* the carrier, required dense shade in which to rear its larvae. The same thing, therefore, was done about the inland town of Kuala Lumpur, but with precisely the opposite effect, plunging the whole anti-malaria effort into confusion and discouragement. Malaria increased tremendously and was a heavy burden for nine years until in 1916 Strickland, an epidemiological entomologist, proved to the satisfaction of the authorities that they had to do with quite another anopheline (*A. maculatus*) of habits and inclinations diametrically opposed to those of *A. umbrosus,* preferring sunlight to shade, and running water to jungle pools. In fact, *umbrosus* was never found at all in Kuala Lumpur, and nevertheless the ranges of the two mosquitoes were not ten miles apart. "Ignorance of the distribution of *umbrosus,*" says Sir Malcolm Watson,[1] "cost the Country much money and many lives."

A similar entomological situation exists in certain regions of Italy, where *maculipennis,* the principal malaria carrier, will not breed in brackish water. Schemes have been evolved and in certain cases successfully carried out for letting the sea into fresh lagoons and low-lying marshes to stop anopheline breeding. The old pre-Ross belief, which held that the admixture of salt water to fresh increased the malaria, was discarded as unscientific. Recently, however, La Face[2] has revealed a hitherto unsuspected fact that in great submerged areas near the mouth of the Po, *maculipennis* is replaced by *elutus,* a mosquito very similar in appearance but different in species, an excellent malaria vector, possessing the ability to breed in salt water. Thus some basis was afforded to an ancient belief and empiricism in mosquito control brought again into well-merited discredit.

America has had such experiences in its tropical possessions. It was found in Panama that the *bromelia,* a parasitic plant growing on the limbs of trees, and holding a quantity of water in its cup-like heart, was widely distributed and was breeding anophelines. In some countries it has been considered a cause of malaria. The project was discussed of seeking out and destroying all these plants. It is probable that Darling saved the Panama Canal hundreds of thousands of dollars by proving in time that no malaria-carrying mosquito was being produced

*Read before National Malaria Committee (Conference on Malaria), meeting conjointly with Southern Medical Association, Twenty-Second Annual Meeting, Asheville, North Carolina, November 12-15, 1928.

by the bromelias of Panama, and that they could be ignored.

In the Philippines our occupying troops were faced with the problem of selecting without delay a healthy location for a large permanent military station. On the basis of the best American experience and of local opinion, it was placed in the hills at a considerable distance from the coastal swamps and marshy plains. Unfortunately subsequent experience and careful surveys have shown that *A. minimus*, the principal malaria carrier in the Philippine islands, breeds only in foothill streams and nowhere on the plains, while *ludowii*, the mosquito of the coastal mangrove swamps, so dangerous in Singapore, is quite innocuous around Manila Bay. The camp had, therefore, been located in the exact center of the most malarious zone of the Island.

Such examples, however, of action based on false premises through ignorance of the differences in behavior of anophelines are drawn mainly from the past. Present day opinion on this subject is crystallized in one of the principal conclusions approved at the recent international conference of malariologists in Geneva in June of this year. Each government is urged to create a small body of trained research workers in malaria, spending all their time in scientific investigation and acting as advisers to the health authorities in the control of malaria. Collaboration between such bodies all over the world, coordinated possibly by some such agency as the Health Section of the League of Nations, would permit the organization of programs of international investigation of certain questions at present unanswerable, and might throw light on some of the theories which now seem to divide the malariological opinion of the world into something like opposing schools of belief.

I would like to illustrate the importance of the international viewpoint by referring to one or two such theories now being actively discussed.

A group of very well-known European malariologists now holds, in substance, that malaria is an anomaly in a civilized country; it is a typical concomitant of abandoned or under-developed lands and primitive conditions where poverty and ignorance chiefly characterize society. In their opinion, malaria will tend to disappear automatically in the presence of intensive cultivation and improved standards of living. Endemic malaria is thus not so much a medical or entomological problem as a social and economic one, and hence it is to the last degree futile to set about attacking the mosquito while these problems remain unsolved. The progress of civilization, aided by a liberal distribution of quinin, will cause malaria to melt away like snow, even though the anophelines remain undiminished in number.

Now, I think it can be sustained that this spontaneous disappearance of malaria in long-established and heavily-infected communities where no measures at all have been consciously taken against Anopheles, is a phenomenon to be observed only in temperate climates, and is possibly limited to Europe. Certainly it is never seen in the tropics, where nevertheless numerous areas of intensive cultivation and considerable prosperity are to be found. Here a reasonable protection from malaria is obtained only at great labor and expense, and no one would maintain for a moment that elaborate agricultural development and a high standard of living would by themselves keep malaria permanently out of the community were the Anopheles allowed to remain. Recent studies of Missiroli and myself[3] point to the fact that "anophelism without malaria" is linked up with the food habits of the European anopheline, *A. maculipennis*, which in certain regions no longer bites man. This is supported by the fact that the introduction of malaria carriers into these regions no longer gives rise to secondary cases of malaria.

Another theory recently proposed both in England and Brazil is that most of the malaria is being transmitted by a relatively few house-loving, well-protected, long-lived and lazy female anophelines, and that the great bulk of the anopheline population is practically not concerned at all in the spread of the disease. Hence house-catching of resting anophelines has been exalted to an important place in methods of malaria control, and generally recommended. Whatever the validity of this theory in regions where anophelines remain in houses after biting, it can have no reference to the major malaria problem of the Far East, where it seems almost to be a rule of etiquette for the mosquito to leave the room immediately after meals. I have myself been guilty of criticising a survey of the anophelines of Ceylon made by H. F. Carter, the Government entomologist, on the ground that the relative densities of species were based on larva counts rather than adult catches. I had no idea until I visited the Far East how difficult it is to lay hands on the adults of most of the principal malaria carriers. In Ceylon, a night's work in houses and stables and around tethered animals out-of-doors on a highly malarious cocoanut estate yielded a few *rossii* and

barbirostris, neither of which is concerned with malaria transmission, while of *culicifacies* or *listonii*, the real malefactors, we saw not a trace. Some sort of trap must be employed, such as a defective bed net. In Malaya, *A. maculatus* disappears completely in the daytime, and though a tiny and fragile insect, subjects itself to the perils of wind and weather rather than lie up in a man-made shelter. In the Philippines attempts to inculpate *A. minimus* by dissection of specimens caught in Nature have failed through lack of material. In seven days spent in the Islands, I did not catch a single one, although a sporting colleague offered as high as a peso apiece for adult specimens. At the same time the larvae were abundant. Now, malaria is rife in all these places and it is evident the anophelines can keep it going, although if they enter houses at all they remain only long enough to bite.

I may mention also the theory that major drainage operations (referred to in Europe as great or integral bonification) have a direct effect on malaria by reducing the number of anophelines. This is an American theory, and it is undoubtedly sound, for whether the water is put underground or not, the drainage of swamps or ponds, and the putting the water into motion in canals, streams or ditches, in America is sufficient usually to abate the *quadrimaculatus*. Even when streams are turned into ponds for power purposes, though there may be at first a period of great *quadrimaculatus* production, after four or five years in some mysterious way the waters become unattractive to the mosquito and the lake can be ignored. It seems to resume the character of a river.

Now, in Europe the *maculipennis* breeds in the edges of moving waters as well as in ponds. This is probably a temperature reaction, since it often abandons still water if it becomes too warm. But the result is that the draining of great plains and deltas, such as that of the Po and the Tiber, with the construction of ditches, intersecting channels and great collecting canals, does not greatly diminish the number of *maculipennis*. As Grassi remarked, you have merely transformed an irregular swamp into a rectilinear swamp, and mosquito production goes on as before. Yet in some cases malaria has begun to disappear after these works, whereas in others it has remained the same or actually increased on account of the increase in population which follows. Hence the European malariologist, doubtful about the relationship between the number of mosquitoes and the intensity of malaria, is driven to utter aphorisms such as "malaria flees before the plow," or (as Cavour said) that beefsteak is the best cure for malaria, or (with Marchoux) that it often seems that the intensity of malaria is in inverse proportion to the number of anophelines. Certainly a profound skepticism reigns in Europe today about the practibility of American ideas of eradicating malaria through mosquito control, and in part this has arisen from the difference in breeding habits between the principal European and the principal American anopheline.

I have cited these three theories which concern the causes of the spontaneous disappearance of malaria, the importance of the few females resting in bedrooms, and the effect of major drainage on malaria, because they are subjects of present discussion, and they seem to turn in each case on the behavior of a particular anopheline, and yet they are often discussed, refuted or defended in literature and conference as though they had general validity. Certainly international contacts and exchanges are of great importance in the science of malariology, if such it can be termed. In many cases, differences between malariologists may thus be resolved pacifically into differences between mosquitoes.

But if the anophelines which transmit malaria have such diverse habits and characteristics all over the world, it nevertheless occurs to us that there must be some profound similarity which makes of them all malaria carriers. The comparative study of them ought surely to reveal why it is that one species is a carrier and another is not. Such a generalization would be extremely useful to all malariologists everywhere.

Such comparative studies, however, bring us upon the very puzzling fact that not only do anopheline species differ one from another, but the same anopheline appears to behave differently in different situations. Take the well-known case of *A. aconitus*. Winoto (1919) found it infected in Western Java to the extent of 7 per cent, while in the same year Swellengrebel in Sumatra dissected over a thousand specimens at the height of an epidemic, and found none positive.[4] We may ask whether it is certain these were really the same mosquito varieties or strains. For example, two strains have been fairly well distinguished in the species *A. ludlowii*, one of which breeds in fresh hill streams, the other in salty mangrove swamps within reach of the highest tides. Now, *ludlowii* is another one of those anophelines which carry

malaria in one region and are harmless in another. But the ability to transmit malaria is not confined to one or the other strain and is apparently not linked up at all with the known bionomic differences. The salt water variety is both the famous fever mosquito of the Javan and Malayan coasts and the perfectly harmless anopheline of the Manila fish ponds. Sections of Batavia and Singapore are rendered almost uninhabitable through the malaria caused by this insect; but in twenty years no authentic case of autocthonous malaria has been reported in Manila.

The strange case of *bifurcatus* throws some light upon the subject. In all parts of Europe it is a wild mosquito never found in houses, but in Palestine alone it enters houses freely and is a most dangerous transmitter of malaria. Is it, then, domesticity which makes carriers of mosquitoes, and can this domesticity be acquired by an anopheline in one region and not in another? The answer is, this cannot be the whole story, for *A. maculipennis* in Europe is a domestic mosquito wherever it is found, but it is not always a malaria carrier. Thus the map of malaria in Europe does not agree with the map of *maculipennis* distribution. And yet *maculipennis* is, with unimportant exceptions in a few localities, the only carrier in all this area. It is in Italy that the problem seems to be presented in its simplest terms. Why, in certain well-defined regions, is *A. maculipennis* a dangerous transmitter of malaria, and why, in other similar regions, is it perfectly harmless, even in great numbers and in the presence of gametocyte carriers? This has been the subject of numerous observations and experiments made during the past three years by Missiroli and myself at the Malaria Experiment Station in Italy. We have come to the conclusion that in that country the amount of malaria in a community is the measure of the degree of contact between *A. maculipennis* and man. This varies greatly from region to region because this anopheline, though always domestic in habits, bites both man and domestic animals, but in differing proportions in different places. Thus on the Tiber Delta one mosquito in four was taken in bedrooms (the highest rate we have yet observed, marking a considerable degree of anthropophilism); in the Pontine Marshes this "host-index" was one in nine; in Massarosa (Tuscany), where malaria appears only as a sporadic case or two at long intervals (just as, let us say, in New York State) the anophelines were plentiful, but only one in four hundred of those captured had bitten man, as shown by the precipitin reaction of the ingested blood; and in Val di Chiana, where malaria is unknown, our party was unable, in two different visits, to find a single specimen containing human blood, nor were we able to be bitten at night, although we intentionally exposed ourselves and the anophelines were very numerous. A very simple mathematical consideration will show that if only one in four hundred mosquitoes bites man, it will take the square of four hundred, or one hundred and sixty thousand mosquitoes, to make sure that the same mosquito will bite two men, a necessary condition for transmitting malaria. The probabilities are further reduced by the chances of the mosquito's dying during the two weeks which must elapse before it can become infective, and by the further chance that the first man bitten may not be a gametocyte carrier. In short, though thousands of anophelines visit the precincts of each family in Massarosa every night in summer, it might take years to fulfill the conditions necessary for a single successful transmission of malaria, even with the constant presence of a gametocyte carrier. Under such conditions, endemic malaria cannot maintain itself, and we have the phenomenon known as "anophelism without malaria." The possibility is not of course excluded that the same phenomenon, if it exists in other regions of the world, may have different causes.

What instinct or circumstance it is which induces *A. maculipennis* in certain places to bite domestic animals to the practical exclusion of man; or just what measure of contact between a given species of anopheles and man is necessary to maintain endemic malaria, cannot now be answered. But if, in spite of what I said about generalizations, I may be allowed to hazard a very conservative and obvious one, I would say that the fundamental similarity between all and diverse kinds of anophelines which transmit malaria in the world is that they all readily bite man, and bite him repeatedly, however widely they may differ in other bionomic characters.

This is so axiomatic that the field of inquiry to which it points would seem to have been insufficiently explored. No doubt it could help us to determine in the presence of a multiplicity of anopheline species the few which are dangerous to our health, and to explain why the same anopheline may be a malaria-vector in one region and quite harmless in another. But I have been interested here not so much in outlining specific problems as in trying to show

that entomology in the service of epidemiology is a fundamental necessity in the study and control of malaria.

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DISCUSSION (*Abstract*)

Dr. I. J. Kligler, New York, N. Y.—It is certainly true that the great point of dissension between malariologists is due to the fact that we have limited our sphere of activity rather too closely and have been thinking more of malaria and less of the mosquito. We have assumed that the only consideration is the human, and that the mosquito is not an entity worth worrying about.

I am not familiar with conditions where one mosquito in 400 bites man; most Anopheles I am familiar with bite man too frequently for our comfort and pleasure. James maintains that infected Anopheles stay in the houses when they become infected.

It so happens that the mosquito we have in Palestine, *A. elutus*, resembles the *maculipennis* existing in Europe and England. For the last year and a half we have examined the infected mosquitoes in houses and stables throughout the various seasons of the year and found a very peculiar condition. We found that *elutus* and *superpictus* behave very differently. Infected *elutus* live more consistently in houses; yet they change their habits: they stay in houses during June to September, but a large part of the infected mosquitoes pass out of doors during the period from September to January.

A. superpictus does not even behave during the summer as does the *A. elutus*. Some are found in houses and some in stables during the summer as well as in the winter.

Various species of *Anopheles* in different parts of the world concerned with malaria differ markedly in their habits. To base, therefore, a broad generalization of the kind which may become one of the principles of the Malaria Commission of the League of Nations on the basis of experience or experiments with one species in one part of a country where malaria is not very prevalent is, to say the least, an unjustified procedure. Such a generalization would affect harmfully the attempts of control of malaria in other parts of the world.

I might cite a single instance of the danger of generalizations from local experience. We have not had the experience of Dr. Hackett where ditching a large, flat marsh has brought about breeding of the same species of mosquito. We have found a transformation in the fauna. *Elutus* is a marsh mosquito, like the *maculipennis*. Ninety-five per cent of the Anopheles in an area were *elutus*. Then the area was drained and very shortly after that the mosquito population changed entirely: instead of 95 per cent *elutus*, the prevailing species was *A. superpictus*, which prefers running to stagnant water. The malaria problem was not solved by the drainage, but control became easier. Had we not been following the habits of the different mosquitoes, we should have found ourselves face to face with a very serious situation; as it was, we were expecting this change and waited long enough for the change to take place, and then took the necessary measures and averted a disaster or disappointment.

RECENT PROGRESS IN MALARIA ERADICATION*

By FREDERICK L. HOFFMAN, LL.D.,†
Wellesley Hills, Mass.

My remarks on the present occasion cover a wide range of international efforts to reduce the incidence of malaria, in some parts of the world to the vanishing point. But the problem still remains an enormous difficulty demanding a concentration of qualified attention on the part of engineers, entomologists, physicians, research workers and scientists generally. Malaria is now, however, infinitely less a mortality problem than a disease problem, particularly in this Country, during recent years. Malaria as a disease also seriously affects many other and more important diseases, hastening death in countless cases in which the organism has been weakened by continued attacks of malaria infection.

My review covers some thirty different countries, which it would be impossible to deal with even in the form of a very brief summary. The address will, therefore, be printed together with the reprints of all my previous papers on malaria and made available to those who wish to pursue the subject further, particularly from a statistical point of view.

In the United States Registration Area, the mortality from malaria has gone down from 3.8 per 100,000 in 1919 to 2.7 in 1927, but for the previous year the rate was only 1.9, so that the increase during the year is suggestive of the urgency of renewed efforts on the part of all concerned. The most conclusive evidence of malaria reduction in this Country under adequate conditions of control is furnished by the United States Army. The disease incidence has been reduced since 1902 from a rate of 201.2 per 1,000 military personnel to 6.7 in 1927. For white enlisted men, the rate at Panama, which

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*Read before National Malaria Committee (Conference on Malaria), meeting conjointly with Southern Medical Association, Twenty-Second Annual Meeting, Asheville, North Carolina, November 12-15, 1928.

†Consulting Statistician, Prudential Insurance Company.

as late as 1921 had been as high as 109 per 100,000, had been reduced to 49.9 during 1927. There had been no deaths from malaria in the Panama Canal Zone among Panama Canal employes since 1924.

Another outstanding experience of malaria control is represented by the admirable efforts of the United Fruit Company in its tropical possessions in the West Indies and Central America. The Company in recent years has been experimenting with treatment by plasmochin with excellent results. Attention in the paper is directed to outbreaks of malaria in sections heretofore considered immune. A most interesting occurrence of this kind is the recent outbreak of malaria in Barbados, which was considered entirely free from the disease and not liable thereto. On the other hand, attention is directed to the extraordinary frequency of malaria in Southern Russia. Most regrettably, Professor Marzinovsky, who expected to have been present, was unfortunately prevented by illness from being with us. In 1923 the number of reported cases in the Union of Soviet Republics was 6,233,000, but this by 1925 had been reduced to 5,141,000.

No malaria survey can ignore the progress made in Italy. The death rate from malaria in Italy, which had been 5.7 per 100,000 in 1914, had by 1918 increased to 32.4, but the rate was reduced to 9.0 during 1925, which was the lowest figure of recent years and which contrasts with a figure of 59.5 during 1887-89.

In Ceylon, for example, the problem is as yet far from being under perfect control. The number of cases of malaria treated in dispensaries in 1926 was as high as 1,061,457, aside from about 29,000 more serious cases treated in hospitals.

For all India, the figures are still more startling. The number of outdoor malaria patients treated at dispensaries increased from 5,519,000 cases in 1916 to 7,704,000 cases in 1925, aside from 1,041,000 more serious cases treated in hospitals.

The foregoing random observations merely emphasize the plea frequently made in the last fifteen years that there is the utmost urgency for a more concentrated effort, but most of all for continuity of effort, amplified by a considerable amount of skill and money if reductions are to be of genuine and lasting value. The problem will not solve itself, but is in need of a vast amount of cooperation for the collection of adequate and trustworthy statistics.

No agency in this Country in this connection can serve a better purpose than the National Malaria Committee in cooperation with the United States Public Health Service, which in season and out has aimed at the gradual eradication of malaria throughout the Southern states. But these two agencies, together with the health agencies of the different states, require much more assistance than has thus far been forthcoming. The road to success will be through continuous efforts, which should not be relaxed when temporary results of value have been attained. At present, there is too much sporadic enthusiasm which hinders rather than helps the real cause of success.

DISCUSSION (*Abstract*)

Dr. L. L. Williams, Jr., Richmond, Va.—Some of you may not know, but I believe most of you do, that Doctor Hoffman was the father of the National Malaria Committee.

Doctor Hoffman said he advised increased activities in certain sections. I had an idea that increase in malaria had stopped and made inquiries in fourteen Southern states. It was rather interesting to note that of these fourteen states, there was a definite increase in ten and a comparative decrease in four. There was a moderate increase in five, a heavy increase in two, and a very heavy increase in three.

A NEW METHOD FOR MECHANICAL DISTRIBUTION OF PARIS GREEN AS AN ANOPHELINE LARVICIDE: PRELIMINARY REPORT*

By J. A. LePrince,†
and
H. A. Johnson,‡
Memphis, Tenn.

Since 1921, when Doctor Barber, of the United States Public Health Service, discovered the high toxicity of paris green against Anopheles larvae, the use of this material has steadily increased, and today it is well known in practically all of the malarious parts of the globe.

For a long time paris green in the ratio of one part paris green to one hundred parts inert dust was restricted to hand distribution. Although this still remains a standard method, the

*Read before National Malaria Committee (Conference on Malaria), meeting conjointly with Southern Medical Association, Twenty-Second Annual Meeting, Asheville, North Carolina, November 12-15, 1928. From Field Investigations of Malaria, United States Public Health Service.

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distribution by mechanical means is of necessity gaining attention. Knapsack dusters have been used successfully, while Williams and Cook have developed a very effective method of distribution from airplanes, using as high as 33 per cent paris green diluted with soapstone.*

Between the hand method for small areas and the airplane method for large tracts there has arisen a demand for a dusting device that would be mobile, economical, easily operated and effective over areas not covered by the other methods. With an idea that such a device could be most advantageously operated from a light boat, the authors proceeded during the season of 1928 to develop a power duster and method of operation that would ultimately prove satisfactory.

A boat of the skiff type, 14 feet by 50 inches, was procured, propelled by a small outboard motor. The blowing equipment consisted of a 600 watt gasoline engine-generator unit and a 100 watt electric driven hand blower. A hopper was installed with an agitator similar to that of the well known flour sifter. This sifted the dust by hand power into the intake pipe of the blower. The dusting outfit proper weighed less than an average sized man and could be carried on the running board of a car. It sits in the boat on spring legs and does not have to be bolted to the boat. Thus it can be easily moved from pond to pond.

In operation 5 to 15 per cent paris green mixed with ordinary hydrated lime was blown diagonally into the air as the boat moved along. Six to ten feet after leaving the nozzle it was picked up by air currents and floated across the area. The distribution was excellent and no heavy, dense coverage of dust occurred near the boat. It is believed that the lightness of hydrated lime was partly responsible for the effective distances covered. The passage of the dust through the fan of the blower materially aids in the diffusion.

In a series of tests of this device at Reelfoot Lake, Tennessee, in areas of dense lily, water star grass, moss and algal mats, we were consistently able to kill all Anopheles larvae up to 450 feet from the boat. The time of application was less than five minutes per acre. One-half pound paris green per acre was found sufficient at this place. The cost of materials (with paris green 20 cents a pound) was therefore approximately 14 cents per acre. The whole outfit can be operated by one man.

Although the device has not been perfected to the point desired, it has already shown itself to be efficient, simple, and economical to operate and well adapted for work in areas where no other method of control is feasible. Other blowers can be added without necessitating extra help and the entire device is extremely flexible for almost any imaginable situation. The complete outfit, including boat and outboard motor, can be set up for a sum not exceeding $500.

While this is a preliminary report only and a complete report of the performance of the device will be published later, something should be said in regard to commercial paris green available for anti-anopheles work.

Numerous instances are on record where paris green has utterly failed to accomplish its purpose and reliable workers have reported poor results with its use. During the past season's work we had occasion to observe the effectiveness and non-effectiveness of two different brands of paris green. With one we got almost no destruction of Anopheles larvae, while with the other we got practically 100 per cent killing. No attempt will be made here to explain the variance of these two samples.

Paris green is stated to be a by-product. It varies in color, density, fineness, dryness, specific gravity and probably in chemical composition. Its varying toxicity is said to be the chief reason why it has been replaced in agriculture by other poisons. The paris green which proved very effective in our experimental work was of a dense, vivid, uniform color and very dry. The manufacturer stated that in tests 95 per cent would pass a 350-mesh bolting cloth such as is used for paint pigments.

It is quite evident that a detailed investigation is necessary in relation to the suitability of paris green for Anopheles control. The time is not far distant when for this work paris green will be purchased according to specifications. What these necessary specifications are we do not yet know, but the United States Public Health Service is at present undertaking an exhaustive study of paris green, and it is believed

*Reprint No. 1140 from the Public Health Reports.

that in a short time much valuable additional information on the suitability of paris green for anti-anopheline work will be available.

DISCUSSION (*Abstract*)

Dr. Felix J. Underwood, Jackson, Miss.—I should like to ask if you worked on a calm or windy day?

Mr. H. A. Johnson, Memphis, Tenn.—We operated on Reelfoot Lake under many conditions of wind velocity. We found no days upon which the dust would not travel. The most satisfactory wind velocity for dust carriage was found by a small pocket anemometer to be from two to five miles per hour. Above five miles per hour considerable vertical motion of the dust cloud was noted and there was a corresponding tendency for the dust to skip certain small areas of vegetation.

THE MISSISSIPPI LAW AND PROGRAM FOR SALT MARSH MOSQUITO CONTROL*

By T. H. D. Griffitts, M.D.,†
Biloxi, Miss.

So far as the writer knows, the first effort that was made in the United States toward the investigation of state-wide mosquito problems, was that by the late Dr. John B. Smith, State Entomologist of New Jersey, in 1900. In that year, according to published records, Dr. Smith, who, in addition to filling the position of State Entomologist, was Entomologist to the New Jersey Agricultural Experiment Station, "secured a small amount of money from the director of the station for a preliminary investigation of the mosquito problem." One of the results of this preliminary investigation was the introduction of a bill in the State Legislature in 1902 which provided for an appropriation of $10,000.00 "for the study of the mosquito problem." This measure failed of passage that year, but the Governor of the State set aside from his emergency fund the sum of $1,000.00, with which Doctor Smith carried on the work in 1902. In 1903, the Legislature made an appropriation of $10,000.00 by the passage of a bill similar to the one introduced in 1902. Doctor Smith submitted a report, published in 1904, showing, among other facts, that "salt marsh mosquitoes migrated as far as 30 miles inland, infesting seriously more than one-half of the State and annoying very seriously nearly three-fourths of the State's population."

Impressed by the facts presented by Doctor Smith, the Legislature of New Jersey, in 1905, passed a bill, one of the provisions of which offered state aid to communities "that cared to spend their own funds in salt marsh drainage for mosquito control." For the fiscal years 1905-6 the sum of $10,000.00 was appropriated for state aid to communities, and an additional sum of $6,000.00 for the use of the Agricultural Experiment Station for the execution of the law and for investigations and experiments. Only one community (the City of Elizabeth) took advantage of the law, so all but $1,000.00 reverted to the State Treasury. The Legislature in 1906 passed an act providing for a survey of all the salt marsh areas within the State and for the abolition of breeding areas; the State to cooperate financially and otherwise with communities, or political units, the State not to contribute more than $500.00 in any single municipality. The Director of the State Agricultural Experiment Station was authorized to expend annually such an amount as was appropriated by the Legislature. The aggregate sum which could be appropriated was limited to $350,000.00, this having been the amount estimated by the State Entomologist as necessary for the completion of the initial drainage of the marshes in the State.

Actual work on the drainage of the salt marsh areas of New Jersey for the elimination of mosquitoes began in 1906, under the provisions of the foregoing law. In 1912, this law was supplemented by one providing for "the establishment of county mosquito extermination commissions and to define their powers and duties." A law of 1915 made the Director of Health of the State of New Jersey ex-officio member of each county mosquito commission. Under the acts of 1906 and 1912 (with amendments in 1915 and 1919) the State of New Jersey has been successfully carrying on her fight against salt marsh mosquitoes, largely by drainage.

Owing to repeated serious invasions by salt marsh mosquitoes in vast areas along the South Atlantic and Gulf Coasts, the Congress, in June, 1926, appropriated for the use of the United States Public Health Service, in cooperation with the Bureau of Entomology of the United States Department of Agriculture, the sum of $25,000.00 "for a preliminary survey of the salt marsh areas of the South Atlantic and Gulf States, to determine the exact character of the

*Read before National Malaria Committee (Conference on Malaria), meeting conjointly with Southern Medical Association, Twenty-Second Annual Meeting, Asheville, North Carolina, November 12-15, 1928.

†Epidemiologist, United States Public Health Service.

breeding places of the salt marsh mosquitoes, in order that a definite idea may be formed as to the best methods of controlling the breeding of such mosquitoes."

By this Act and subsequent appropriations (aggregating $50,000.00) the Federal Government has for the first time officially recognized the importance of the salt marsh migrating mosquitoes in their effect on the general welfare of the Atlantic and Gulf Coast sections.

Headquarters for the survey were established at Biloxi on the Mississippi Gulf Coast. Based on determinations made in the first two years of the survey, and the desire to inaugurate much needed control measures, the Mississippi Legislature passed an act which became a law in April, 1928, providing for the appointment and functioning of "County Mosquito Control Commissions" and for special taxation by counties to secure funds for carrying on the work.

The Mississippi mosquito control law is as follows:

An Act enabling the establishment of County Mosquito Control Commissions and to define their powers and duties, and for other purposes.

Section 1. Be it enacted by the Legislature of the State of *Mississippi,* That the *county board of supervisors* in any county of this State may, with the approval of the State Health Officer, appoint *three* persons who will constitute a board of commissioners of said county to be known as "The County Mosquito *Control* Commission" (inserting the name of the county in and for which the commissioners are appointed). The Commissioners first appointed under the provisions of this Act in any county shall hold office, respectively, for the term of one, two, and three years, as indicated and fixed in the order of appointment, and all such commissioners, after the first appointment, shall be so appointed for the full term of three years; vacancies in the said commission occurring by resignation or otherwise shall be filled by *the County Board of Supervisors with the approval of the State Health Officer,* and the persons appointed to fill such vacancies shall be appointed for the unexpired term only; such persons so appointed, when duly qualified, constituting such commission and their successors are hereby created a body politic, with power to sue and be sued, to use a common seal and make by-laws; the members of any such commission shall serve without compensation, except that the necessary expenses of each commissioner for actual attendance of meetings *and per diem of* $5.00, *the total per diem not to exceed* $25.00 *for any one commissioner per month,* of said commission shall be allowed and paid. *The president and secretary shall furnish bond in the amount of* $5,000.00 *each, the fee for same to be charged to available funds obtained for the work herein mentioned.* No persons employed by the said commission shall be a member thereof; before entering upon the duties of his office each commissioner shall take and subscribe an oath or affirmation before the clerk of the county in and for which he is appointed to faithfully and impartially perform the duties of his office, which oath or affirmation shall be filed with the clerk of the county wherein the commission of which he is a member is appointed; every such commission shall annually choose from among its members a president and treasurer and *employ a director who is trained in mosquito control operations, and whose duty it shall be to direct the work of the commission as its executive,* a clerk or secretary, and such other help as it may deem necessary to carry out the purposes of this Act; it may also determine the duties and compensation of such employees, and make all rules and regulations respecting the same. It shall be the duty of the *county board of supervisors* in each county to provide such commission with a suitable office, where its *meetings may be held,* its maps, plans, documents, records and accounts shall be kept, *and office work carried on. The commission shall hold monthly meetings, and not less than two members shall constitute a quorum.*

Section 2. The *State Health Officer* shall be a member ex-officio of each commission and shall cooperate with them for the effective carrying out of their plans and work. The said *State Health Officer shall serve* without compensation, except that the necessary expenses actually incurred by him in the attendance of meetings of said commissions shall be allowed and paid. The *State Board of Health or its representative* shall, *upon request of the commission,* furnish the said commissions with such surveys, maps, information and advice as *may be available* for the prosecution of the work, or, as in their opinion, will be advantage in connection therewith, *the expense of surveys being paid, in whole or in part, by said commission.*

Section 3. *Two or more counties may combine for the purpose of carrying out the provisions of this Act in the respective counties, each county retaining all rights set forth in this Act, but the commissioners in the counties combined may enter into agreement to employ, for purposes of economy, the same director and other personnel for the work of the commissions in the counties so combined, all expenses, including salaries, labor, material and the like being paid by the county in which the work is performed.*

Section 4. *The county board of supervisors and board of commissioners so appointed may, with the approval of the State Health Officer, receive and accept any aid whatsoever from any source calculated to further the success of a plan or plans based on the provisions of this Act.*

Section 5. Every such commission shall have the power to eliminate all breeding and *producing* places of mosquitoes within the county wherein it is appointed, and to do and perform all acts and to carry out all plans which in their opinion and judgment may be necessary or proper for the *survey and* elimination of breeding *and producing* places of mosquitoes or which will tend to exterminate mosquitoes within said county.

Section 6. Said commission shall, on or before the first day of November in each and every year, file with the *State Health Officer* a detailed estimate of the moneys required for the ensuing year, and a plan of the work to be done and the methods to be employed. The said *State Health Officer* shall have the power to approve, modify or alter the said estimates, plans and methods and the estimate, plan and method finally approved by him shall be forwarded to the *county board of supervisors* in each county on or before the first day of December following its receipt.

Section 7. The *county board of supervisors* of each county or other body having control of the finances

thereof, *may* include the amount of money approved by the *commission and the State Health Officer* annually in the tax levy; provided, however, that in no year shall the amount so raised exceed the amount hereinafter specified, to wit, in counties where the assessed valuations are *less than* $20,000,000.00, a sum not greater than *one* and *one-half mills* on every dollar of assessed valuations; in counties where the assessed valuations are $20,000,000.00 *or over*, a sum not more than *one mill* on every dollar of assessed valuations.

Section 8. The moneys so raised, or so much thereof as *may* be required, may be paid from time to time for the *operations, work, materials and labor of said* commission duly signed and approved by the president and secretary thereof *by order of the board of supervisors.*

Section 9. It shall be the duty of each commission annually, on or before the *20th day of January* in each year, to submit to the *State Health Officer and to the county board of supervisors* in their respective counties, a report setting forth the amount of moneys expended during the previous year; the methods employed, the work accomplished, and any other information which, in the judgment of the *board of supervisors,* may seem pertinent.

Section 10. Nothing in this Act shall be construed to alter, amend, modify or repeal any act now existing conferring upon State or local boards of health any powers or duties in connection with the extermination of mosquitoes in said State, but shall be construed to be supplementary thereto.

Section 11. *Provided that this Act shall only apply to counties bordering on tide-water and on the Mississippi River.*

Section 12. This Act shall take effect immediately upon its passage and approval.

Approved, April 23, 1928.

This law, in its main features, is quite similar to the law under which the State of New Jersey is ridding itself of the great salt marsh pests. The parts of the Mississippi Act appearing in *italics* are those differing from the New Jersey act. Sections 3 and 4 are new and provide for the combining of two or more counties, for purposes of economy, efficiency and coordination of efforts, and for the acceptance of aid from any source calculated to promote the success of the plan, or plans, adopted.

To summarize, the Mississippi salt marsh mosquito control law provides for:

(1) The appointment by the county board of supervisors, with the approval of the State Health Officer, of a mosquito control commission, to be composed of three members, each serving for a term of three years, each member to receive actual expenses and a per diem of $5.00, which per diem shall not aggregate more than $25.00 per month. The commission is to employ a trained director, other personnel and labor, and provide an office.

(2) The State Health Officer is a member ex-officio of each county commission, receives actual expenses and provides for surveys, maps, information and advice.

(3) Two or more counties may combine for purposes of economy, efficiency and coordination of the work.

(4) The counties may, with the approval of the State Health Officer, receive aid from other sources.

(5) The commission has power to survey and to eliminate all breeding and producing places of mosquitoes in the county.

(6) The commission, on or before the first day of November of each year, shall file with the State Health Officer an estimate of moneys needed and plans for work for the ensuing year, and he has authority for final approval.

(7) The county board of supervisors may include the amount of money approved by the commission and State Health Officer in each annual tax levy. In counties where the assessed valuations are less than $20,000,000.00, the rate shall not be greater than *one and one-half mills;* in counties of $20,000,000.00 or over, the rate is not greater than *one mill* on every dollar of assessed valuations.

(8) Expenditures are to be made upon the written approval of the commission and by order of the board of supervisors.

(9) An annual report to the State Health Officer and the county board of supervisors is required of the commission.

(10) The Act affects no existing Act, except that it supplements existing laws.

(11) The law, while primarily aimed at salt marsh mosquito control in the three coastal counties, also applies to those counties bordering on the Mississippi River.

The survey made by the United States Public Health Service has shown the economic feasibility of the control of salt marsh mosquito breeding in Mississippi, largely by drainage. This State is fortunate in having the least marsh acreage of all the Southern states, having approximately 26,500 acres of salt marsh (Harrison County 2,300; Hancock County, 5,200, and Jackson County 19,000 acres). This amount includes the mainland marshes and the marsh areas on the off-shore islands (Petit Bois Island, Horn Island, Ship Island, Deer Island, and Cat Island). According to the soil conditions, these marsh areas are divided into two classes: muck marshes occurring generally at the mouths of rivers from silt brought down stream, and sand or sandy loam along main shores or on the islands. Drainage in the muck marshes is the more satisfactory method of control as to cost and permanency, but drainage (necessary for mosquito control) is feasible in either class. Much of the marsh areas, particularly the muck islands, are so covered by daily tides as not to be producers of mosquitoes. This reduces the areas actually demanding control work to approximately 6,000 acres. Based on costs of similar work and added expense on account of transportation to islands, etc., it is estimated that the initial cost of mosquito drainage for Mississippi will be approximately $60,000.00, or $10.00 per acre.

One county (Harrison) has already appropriated $20,000.00 and will start drainage by February of next year, it is stated. It was hoped

that the other two coastal counties would make appropriations for the ensuing year, but they have failed to do so. It is believed that, based on the survey made by the Public Health Service, Mississippi, through local appropriations for the work and detailed surveys, will eliminate the salt marsh mosquito pests as well as the two salt-water Anopheles (*crucians* and *atropos*).

Contributing to the general movement to control salt marsh mosquitoes, the States of Virginia and Florida have already passed laws similarly dealing with the problem, while other states, recognizing the feasibility of control, its economic and public welfare aspects, are becoming interested in plans. It is not too much to expect that within a few years the populated coastal sections will have taken steps to control this great enemy of man and beast.

DISCUSSION (*Abstract*)

Dr. John H. Hamilton, Wilmington, N. C.—Being from the eastern part of North Carolina, I am cognizant of the handicap to which we are subjected by the salt marsh mosquito. I believe Doctor Griffitts has devised a plan which will enable us to do something about this matter.

Our people are not content to be rid of Anopheles mosquitoes only. They demand freedom from all mosquitoes.

Whenever we start a malaria program which affects Anopheles, we must plan to control all mosquitoes that are capable of biting.

Dr. L. L. Williams, Jr., Richmond, Va.—It should be noted that the Mississippi law covers mosquito control other than that of the salt marsh mosquito.

In the malaria sections of the State of Mississippi Anopheles control on a county-wide basis can be attempted. The county health department is the essential nucleus for Anopheles control.

I believe we can create a demand for malaria control through mosquito control rather than just pest control. Heretofore we have been very much handicapped: we started out with expensive drainage and oiling, which did not apply to rural districts; then we restricted the area of control and the type of control to *quadrimaculatus* only; then we had paris green; and now the screening program. I am inclined to believe that with all these plans combined *Anopheles* control on a county-wide basis has at last come within the scope of the people; the time has come for us to push that plan. If we can get a county health department to undertake mosquito control, then that is all right; if not, we must organize some commission for county-wide mosquito control.

Dr. C. W. Garrison, Little Rock, Ark.—Has the State of Mississippi made an appropriation for State aid of counties effecting malaria control under this Act?

Dr. Felix J. Underwood, Jackson, Miss.—No. This Act of the Legislature does not carry an appropriation and has nothing to do with the appropriation for the State Board of Health.

Dr. Griffitts (closing).—I mentioned that Virginia and Florida had passed laws providing for salt marsh mosquito control.

The Virginia law, I understand, provides for state aid in local work, and applies only to the tide-water section, consequently has to do with salt marsh mosquitoes only. The Mississippi law, like most other laws, is not offered at first as a finished product. It very probably will need amendments from time to time after control work is well under way. There may be objections in some states to the creation of an additional commission as provided for in the Mississippi Act. For instance, in Florida it is generally felt that the county boards of supervisors should constitute the mosquito control commission and handle the control work directly. Generally speaking, there is a prejudice against a multiplicity of boards or commissions, and I know of no reason why, under such circumstances, the county board of supervisors should not take on this added function.

It is a source of gratification that the first county in the South Atlantic and Gulf States to make an appropriation for salt marsh mosquito control as a direct result of the preliminary survey which is being conducted by the Public Health Service was Harrison County, Mississippi, in which the headquarters for the survey are located. It is expected that the other two Mississippi coastal counties will make proper appropriations very soon, and that general public sentiment will create a demand for concerted action in all of the Atlantic and Gulf states included in the survey. The damage done by the salt marsh mosquito has already been recognized as one of interstate importance, and I feel sure now that the ultimate result of the survey undertaken by the Federal Government will be the reduction of salt marsh mosquitoes to the point where they will not be a ruling influence in the coastal sections.

PREVALENCE OF MALARIA IN HUMPHREYS AND SUNFLOWER COUNTIES, MISSISSIPPI, IN 1927-1928*†

By PAUL S. CARLEY, M.D.,‡
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and

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The State of Mississippi has had the reputation of being one of the most heavily infected malaria sections in the United States. While there are parts of the State from which malaria is seldom reported, the area known as the Mississippi Delta is the one in which the greatest prevalence of the disease is generally conceded. About 25 per cent of the population of the State resides in the Delta, and more than 50 per cent of all the malaria reported to the State Board of Health is reported from that section. Hum-

*Read before National Malaria Committee (Conference on Malaria), meeting conjointly with Southern Medical Association, Twenty-Second Annual Meeting, Asheville, North Carolina, November 12-15, 1928.

†These studies were carried out under the auspices and with the support of the Mississippi State Department of Health and of the International Health Division of the Rockefeller Foundation.

‡Field Staff. International Health Division, Rockefeller Foundation.

phreys and Sunflower Counties lie in west central Mississippi, in the Delta. The topography of both counties is flat and the soil is a rich alluvial deposit. Each county is transversed by numerous small water courses; lakes and swamps are numerous. Humphreys County lies directly south of Sunflower County and was completely inundated by the floods of the spring of 1927, while Sunflower County was flooded on its lower third.

In 1920 Sunflower County had a population of 46,374; Humphreys in that year had a population of 19,192. In both counties the racial ratio is about one white to three negroes. The estimated population computed for 1927 gives Sunflower County 58,920 and Humphreys County 20,683 inhabitants. In both counties the major industry is the raising of long staple cotton. The general economic condition of the inhabitants may be rated as fair. More specifically, the economic condition of the counties reflects, from year to year, the market price of cotton.

Some of the first work done in malaria observation and control in the United States was carried out in Sunflower County and the adjoining (Bolivar) County by Bass[1] and his associates in 1916-1918. Their data on the incidence of malaria included histories and the results of thick blood film examinations. In 1918 an area of 100 square miles in Sunflower County was surveyed, which included 8,053 persons of all ages. A positive history of malaria signified one or more attacks of malaria in the previous twelve months. Among this group 36.3 per cent gave positive histories, while in a group of 7,639 persons 22.2 per cent showed positive bloods. In Bolivar, the adjoining Delta County, during 1916-1917, 31,459 persons living in an area of 328 square miles were interviewed and examined. The positive history index was 40 per cent and the blood index was 21.2 per cent. Bass added the number of positive histories and the number of positive blood examinations occurring among the persons who gave negative histories and arrived at an index of about 50 per cent as representing the prevalence of malaria in those areas of Sunflower and Bolivar Counties at that time. Whether or not we accept a positive history as a criterion of malaria infection, it must be admitted that the blood indices of 21 and 22 per cent obtained by only one examination, represent for those two counties in 1916-1918 less than the actual amount of acute and chronic malaria, which was indeed a high incidence of the disease.

After an interval of ten years the State of Mississippi, and the Delta in particular, still have the reputation both among physicians and the laymen of having a high incidence of malaria. Most of the evidence in support of this opinion comes from the number of cases of malaria reported monthly to the State Bureau of Vital Statistics. Relatively few of these reported cases are supported by blood examination. In 1927, 88,302 cases of malaria were reported from the whole State, giving a case rate of approximately 49 per 1,000. A summary of the blood examinations made for the diagnosis of the disease in the state, county and city laboratories reporting to the Division of Malaria Control of the State Board of Health is given below.

Year	Total Exam.	Positive Exam.	Per Cent Positive
1924	10,351	1,985	19.2%
1925	11,630	1,699	14.6%
1926	10,491	1,493	14.2%

It may be observed that for the three years from 1924-1926 about 10,000 blood smears have been examined annually in the public laboratories. Of these suspected cases 15 to 20 per cent have been found positive. On the other hand, the positive blood examinations represent only about 2 per cent of the total number of cases of malaria reported. The majority of these reports, therefore, are clinical diagnoses.

Chart I shows the malaria case rate per 1,000 population in the two Delta counties considered in this report and in the six surrounding counties from 1919-1927. According to these data, 7.5 per cent of the population of Humphreys County and 10 per cent of the Sunflower County population came under the observation of the county physicians in 1927 because of malaria. It has been stated that only one of three or one of five cases of malaria is seen or treated by a physician. If so, a rather formidable sickness rate due to malaria must occur in these counties. Whatever may be the accuracy of these morbidity data, it is reasonable to note that since 1919 there has been a distinctly downward trend in the malaria morbidity rate in the counties included in the graph.

Since very little data are available to show the present status of malaria by surveys on the population at large, it may be of interest to present the results of spleen and blood examinations in Humphreys and Sunflower Counties made in 1927-1928.

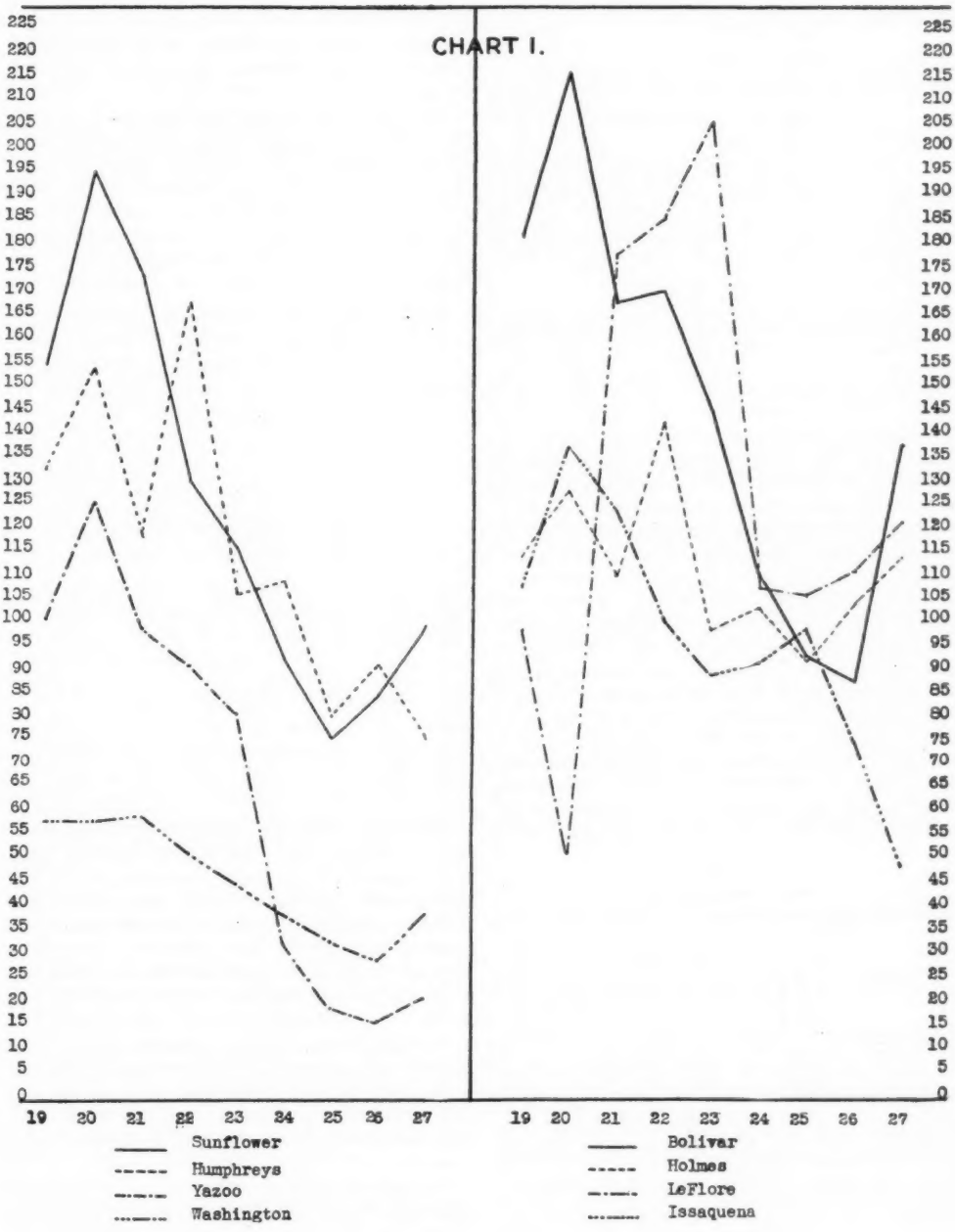
CHART I.
225 220 215 210 205 200 195 190 185 180 175 170 165 160 155 150 145 140 135 130 125 120 115 110 105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0
19 20 21 22 23 24 25 26 27
Sunflower
Humphreys
Yazoo
Washington
Bolivar
Holmes
LeFlore
Issaquena

In *Table 1* the results of spleen examinations carried out in the counties are summarized by age groups.

TABLE 1

Spleen Examinations

County	No. Exam.	Age Groups 5	5-9	10-14	15 up	No. Pos.	Spleen Rate
White—							
Humphreys	427	0	217	179	31	15	
Sunflower	401	3	169	125	104	18	
Total	828	3	386	304	135	33	4.0%
Colored—							
Humphreys	980	94	414	436	36	10	
Sunflower	188	45	57	39	47	3	
Total	1168	139	475	475	83	13	1.1%

Age Distribution, Palpable Spleens, Both Counties

	5	5-9	10-14	15 up
White	0	17	13	3
Colored	0	7	4	2

All spleen examinations were made on school boys. The boy being examined was placed in the dorsal decubitus position and the legs flexed. The examination was carried out on the bare abdomen. Only those spleens which could be felt on normal respiratory effort or which extended below the costal margin were noted as positive. We agree with Maxcy, Barber and Komp[2] that the inclusion of spleens palpable on forced respiration or by very delicate examinations tends to include too large a group of normal spleens in the positive group. The results of these examinations give a spleen rate, among a group of 828 white school boys, of 4 per cent. The variation in the spleen rate in the two groups is attributed to racial differences rather than any difference in opportunity of becoming infected with malaria, for, as Clark[3] and others have pointed out, it seems that the negro is less liable to show splenic enlargement than the white.

TABLE 2

Blood Examinations

County	Number Exam.	Age Groups 5	5-9	10-14	15 up	Number Positive	Blood Rate
White—							
Humphreys	427	0	217	179	31	7	
Sunflower	577	3	219	149	206	3	
Total	1004	3	436	328	237	10	1.0%
Colored—							
Humphreys	3723	248	841	931	1703	55	
Sunflower	764	121	127	79	437	23	
Total	4487	369	968	1010	2140	78	1.7%

Age Distribution, Positive Cases, Both Counties.

	No. Exam.	Age Groups 5	5-9	10-14	15 up
White	10	1	5	4	0
Colored	78	1	28	31	18

Table 2 shows the results of blood examinations in both counties, summarized by age groups.

All blood examinations reported were done on thick films, dehemoglobinized with distilled water and stained with Giemsa's stain. At the time the thick film was obtained in the field a thin smear was made on the opposite half of the slide. In all cases reported as positive the film was examined after the diagnosis had been made from the thick smear for confirmation.*

Table 3 shows the number of blood examinations by months and is further divided to show the type of parasites found in the positive smears.

TABLE 3

	Number Exam.	Positive all Types	Per Cent Positive	Positive P. Vivax	Positive P. Falcip.	Positive P. Malariae	Positive Type Undetermined
1927							
Aug.	187	9	5	0	3	0	6
Sept.	866	13	1.5	11	2	0	0
Oct.	771	13	1.7	6	3	2	2
Nov.	129	6	5	6	0	0	0
Dec.	104	2	2	0	1	0	1
1928							
Jan.	504	14	2.8	13	1	0	0
Feb.	146	3	2	3	0	0	0
Mar.	351	3	0.9	3	0	0	0
April	.....	....	....	....	....	....	....
May	123	0	0	0	0	0	0
June	1317	16	1.2	8	3	0	5
July	505	5	1	1	3	0	1
Aug.	488	4	.8	1	2	0	1
Total	5491	88	1.6%	59 %	20 %	2%	19%

The blood index for a total of 5,491 examinations is 1.6 per cent. The highest monthly rates were found in August and November, 1927, but this monthly variation is not particularly significant owing to the rather limited number of examinations during these months. The division of the 88 positive examinations shows 59, 20, 2 and 19 per cent for vivax, falciparum, malariae and undiagnosed types, respectively.

In Humphreys County selected houses were visited at least once a fortnight during the period reported, and Anopheles were caught inside and under the houses. No specimens of any Anopheles except *A. quadrimaculatus* were

*The authors are very grateful to Dr. T. W. Kemmerer, Director of the State Hygienic Laboratory of Mississippi, and to Dr. Mark F. Boyd, Director of the Station for Field Studies in Malaria at Edenton, N. C., for their assistance in interpretation of many of the blood specimens collected in this survey.

found inside the houses. During all collections in barns and under houses, in the period under consideration only twenty-four specimens of *A. punctipennis*, three specimens of *A. pseudopunctipennis* and one specimen of *A. crucians* were taken. The following table shows the total number of *A. quadrimaculatus* caught monthly, the number of inspections made and the average number of *A. quadrimaculatus* caught per house (ten minutes' search per house).

TABLE 4

Month	Total No. A. Quad. Caught	Number Houses Exam.	Average No. A. Quad. per House
1927 August	316	20	15.6
September	1248	88	14.1
October	251	42	6.2
November	109	39	5.
December	12	70	.17
1928 January	33	35	.9
February	21	41	.5
March	40	37	1.0
April	110	22	5.
May	1420	72	19.7
June	2013	130	15.4
July	865	45	19.2
August	780	48	16.6
September	785	39	15.
October	69	21	3.3

The results serve to emphasize the already known fact that *A. quadrimaculatus* greatly predominates over all other species of anophelines in the Delta of Mississippi.

SUMMARY

There are presented the results of 1,996 examinations for splenic enlargements on colored and white school boys, together with the results of 5,491 thick blood film examinations on blood specimens obtained from colored and white residents in two Mississippi Delta counties. The malaria morbidity rate, based on physicians' reports, for these counties and six surrounding counties during the period 1919-1927 is given. The results of routine search for anopheline mosquitoes at selected stations in Humphrey County during the period August, 1927, to October, 1928, is added.

Judging from the number of cases reported to the State Board of Health by practising physicians in the area studied, there has been a definite downward trend in malaria morbidity.

The results of spleen examinations indicate that 4.0 per cent of white school boys and 1.1 per cent of colored boys in the area under observation showed palpable splenic enlargement on one examination.

The single examination of 5,491 blood specimens gave a blood index of parasite rate of 1.6 per cent. This shows an enormous decrease in the ten years since the observations made by Bass in one of these two counties.

The anopheline density is high in Humphreys County and *A. quadrimaculatus* is the overwhelmingly predominant anopheline.

From the results of spleen and blood examinations, it may be stated that there is wide discrepancy between the malaria rate as reported by practising physicians and the amount of malaria demonstrable by physical or laboratory methods.

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3. Clark, H. S.: Spleens and Parasite Rates as a Measure of Malaria in the Caribbean Area. Amer. Jour. Trop. Med., 8:423-442, Sept., 1928.

DISCUSSION (*Abstract*)

Dr. M. A. Barber, Greenwood, Miss.—In Leflore County, Mississippi, we obtained somewhat higher blood parasitic indices than those obtained in Humphreys and Sunflower Counties by Dr. Carley. In the April and May, 1928, examinations, 240 white school children gave 6.3 per cent positive. These children lived in the country; only rural pupils were examined among the children of the schools of larger towns. In the autumn of 1928 the same schools gave 5.2 per cent positive. Negro rural schools gave a somewhat higher rate: of 365 children examined in the spring of 1928 21.6 per cent were positive. The autumn examination of these negro schools has not yet been finished, but it promises to give a lower rate than that of the spring. Of negro children in larger towns, 198 gave 5.1 per cent positive in the spring examination of 1928. Of a total of 862 school children of both races examined during the spring of 1928, 12.9 per cent were positive.

Probably we included in our examinations a larger percentage of small rural schools than Dr. Carley did in his series, and such selection may partly account for our higher rates.

Apparently the rates obtained in this County during the fall of 1927 and spring of 1928 are higher than those we are getting during the autumn of 1928.

I have been obtaining some interesting results from the monthly re-examination of a group of negro children found blood positive in the spring of 1928. The work has not been completed, but it would appear that in a group of this kind a single examination may reveal less than half of the parasitic carriers. At all events, so many of the negatives obtained at a given examination subsequently become positive that it is hard to attribute the result to re-infections.

I believe that the examination of blood for malaria

parasites gives more satisfactory results in the determination of endemic malaria as it occurs in this Country than does any other single test. The difficulties of the blood examination are commonly exaggerated. The main thing is to use thick smears and have them properly collected and stained. In working with poor preparations one suffers much eye strain and loss of time in trying to distinguish parasites from finger dirt. With good preparations an examination of two minutes per thick specimen may be as good as five minutes or more on a poor one.

Dr. M. C. Balfour, New York, N. Y.—The paper presented by Doctor Carley had several objects: (1) to call your attention to the remarkable drop in the blood index of a large group of people living in the Mississippi Delta as compared with the blood indices found ten years ago when Dr. C. C. Bass made observations in the same area; (2) to present evidence regarding the relatively low incidence of malaria as measured by the blood and spleen indices at the present time; and (3) to point out the wide discrepancy between malaria morbidity based on physicians' clinical reports and the measurement of malaria incidence obtained by spleen and blood examinations.

To supplement Doctor Carley's paper, it may be observed that the blood index reported by him as 2 per cent or less represents the average for the year. The blood indices by months varied, of course. However, the month in which the highest rate existed was not more than 5 or 6 per cent.

The persons examined represent fair samples of the two counties. In Humphreys and Sunflower Counties there are no towns or cities which have a population of over 2,200, therefore the area is essentially rural. Some of those examinations were made on town children, but the majority of them were of children living on plantations.

Dr. L. W. Hackett, Rome, Italy—I should like to ask Doctor Carley whether there has been any great increase in the dairy industry in those counties during this decrease in malaria?

Dr. Henry E. Meleney, Nashville, Tenn.—I wish to ask Doctor Carley whether he feels that the treatment of cases during this period was responsible for the great difference between the history index and the spleen and blood indices in his cases? It certainly is a factor in some communities.

Dr. Carley (closing).—The rates shown in the graph represent the total number of blood and spleen tests made. Some of the months were higher and some lower than the index as given. The rate I gave was simply a moving picture or running rate for the entire period, and that explains why our figures are somewhat lower than you might expect.

The blood examinations were done mostly under the direction of Doctor Kemmerer, and about 600 were done by Doctor Boyd; I did, roughly, one-third myself. This is simply a picture of malaria as we found it in 1927 and 1928.

We are not prophesying, nor are we doing any more than giving the data found.

In answer to Doctor Hackett's question, there has been no perceptible increase, so far as has been determined, in Humphreys County in the past ten years; there has been a slight increase in Sunflower County. In an attempt to determine whether or not the presence of livestock in the vicinity of the houses whose inhabitants were examined had any bearing on the presence or absence of malaria, we took a rather complete census of all stock near the residence of 2,000 colored rural inhabitants as the routine examinations were being made. Our positive findings in that group were unfortunately very small: so far as could be determined the presence of livestock near habitations played no part in the question of the amount of malaria in the inhabitants of these houses.

As to whether or not treatment plays an important part in the discrepancies in history rate, and spleen and blood rate, I do not feel I am able to answer. I have no doubt since the time of Doctor Bass' work that chill tonic has played its part in cutting down the blood rate. As to the spleen rate, I do not know. Quinin is very freely taken in the Delta. Certainly it plays a part in the blood rate; but, whether or not an important part, I do not feel equal to saying.

OBSERVATIONS ON THE MALARIA PROBLEM OF WEST TENNESSEE*†

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West Tennessee is that portion of the State lying between the Tennessee River on the east and the Mississippi River on the west. In this region it has been believed from scattered observations that the malaria problem is essentially that of the alluvial valley of the Mississippi, and as such is a part of the malaria problem of the entire Mississippi Delta. This problem is intimately associated with the flooding of low lands, and in Tennessee would be expected to differ from the problem in the other Delta states only in the extent of the territory involved. The relative amount of territory subject to overflow from the Mississippi River in the other Delta states as compared with Tennessee is shown in *Table 1*. Tennessee contains only 1.5 per cent of the land subject to overflow in the Mississippi Delta. For this reason, both the malaria problem and the flood problem have attracted less attention in Tennessee than in the other states.

In connection with the flood control program, Tennessee will also probably receive little attention in the immediate future, for, although the Federal flood control program contemplates

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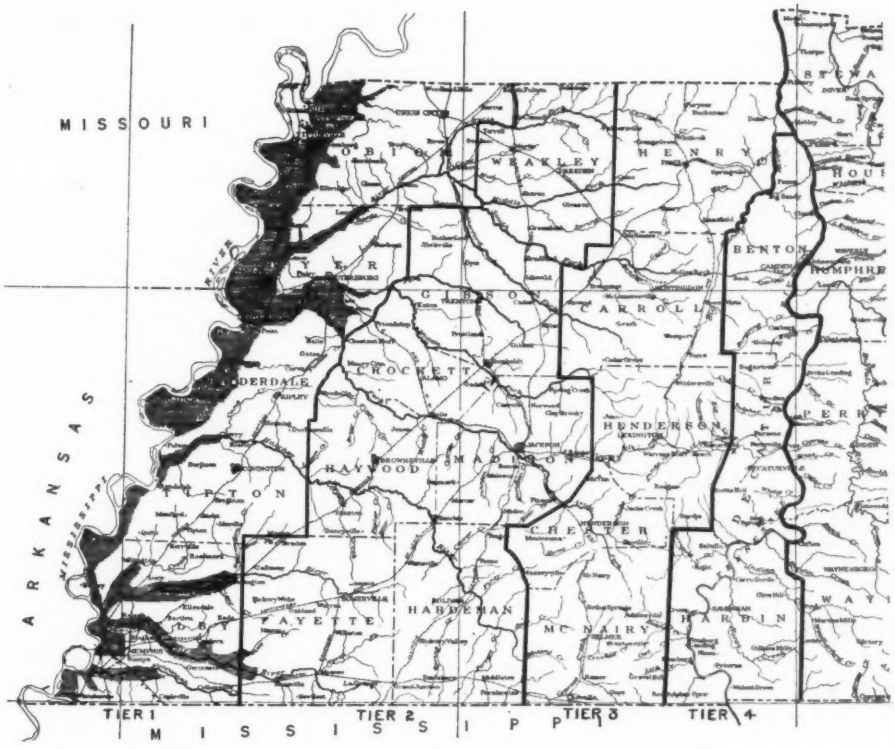
*Read before National Malaria Committee (Conference on Malaria), meeting conjointly with Southern Medical Association, Twenty-Second Annual Meeting, Asheville, North Carolina, November 12-15, 1928.

†From the Tennessee State Department of Public Health and the Department of Preventive Medicine and Public Health, Vanderbilt University.



Map 1

West Tennessee, showing the land subject to overflow during floods of the Mississippi River, and showing in tiers the counties which have similar topographical conditions.

the more efficient protection of territory already protected from floods, it reserves for overflow and backwater all territory which is not at present at least partially protected. The whole western border of Tennessee is included in this unprotected area. This principle in the flood control program cannot be criticised, since it is essential to the success of the whole project for controlling superfloods, but it emphasizes the difficulty of future attempts to eliminate Anopheles breeding places in the unprotected alluvial valley in Tennessee.

TABLE 1
The Amount of Land Subject to Overflow in Tennessee Compared with that in the Other Mississippi Delta States.

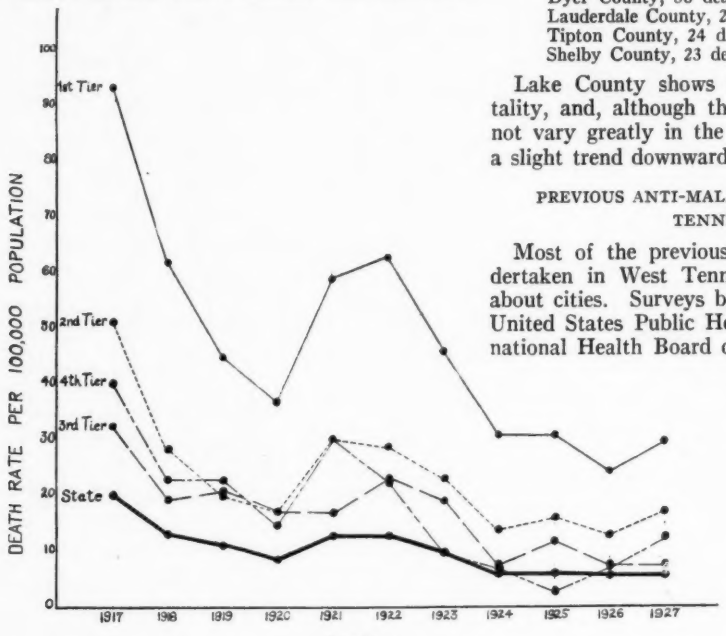
State	Square miles subject to overflow*	Compared with Tennessee
Illinois	65	1/7
Kentucky	125	1/4
Tennessee	453	1
Missouri	2,874	6
Arkansas	4,652	11
Mississippi	6,926	15
Louisiana	14,695	32
Total	29,790	66

*These figures are taken from the map of the alluvial valley of the Mississippi from the head of the St. Francis Basin to the Gulf of Mexico, published by the Mississippi River Commission in 1887, and last revised in 1907.

Map 1 shows the portion of West Tennessee which is subject to the overflow of the Mississippi River. This includes not only territory directly adjacent to the river, but also the valleys of the tributary streams, namely: the Obion, Forked Deer, Hatchie, Loosahatchie and Wolf Rivers, as well as several smaller creeks and the region around Reelfoot Lake. According to Ashley,[1] the valleys of these tributary streams range from one-fourth of a mile to four miles in width. Their lower courses have a fall of only about a foot to the mile. This rises to two feet in the middle courses and three or four feet in the upper courses. On the Obion River, for instance, the fall averages less than one and one-half feet per mile as far as the town of

Obion, which is about 45 miles from the river's mouth. This indicates that the area of backwater in the valleys of these streams during flood is considerable, and that in Tennessee the flood problem extends beyond the valley of the Mississippi River itself into the valleys of its tributaries.

Map 1 divides West Tennessee into four tiers of counties. All of the counties in Tier I border on the Mississippi except Obion, which corresponds to the hilly portion of Dyer County. Tier II contains the middle courses of the tributary streams flowing west. Tier III contains the divide between the valleys of the Mississippi and Tennessee Rivers. Tier IV contains the tributaries and the valley of the Tennessee River.



Graph 1

The annual mortality from malaria in the four tiers of counties of West Tennessee and in the State of Tennessee as a whole for the years 1917-1927.

Although mortality statistics are not an accurate index of the size of the malaria problem, nevertheless they do indicate that the problem is most important in the counties bordering on the Mississippi, and is present in other counties of West Tennessee. *Graph 1* shows the reported death rate from malaria since Tennessee was admitted to the Registration Area in 1917. It shows the death rate for the four tiers of counties of West Tennessee as compared with the rate for the entire State, and demonstrates the relatively high rate in the Mississippi counties. For the years 1925, 1926 and 1927 the five Mississippi counties led the State in malaria death rates as follows:

Lake County, 68 deaths per 100,000.
Obion County, 31 deaths per 100,000.
Dyer County, 30 deaths per 100,000.
Lauderdale County, 28 deaths per 100,000.
Tipton County, 24 deaths per 100,000.
Shelby County, 23 deaths per 100,000.

Lake County shows much the highest mortality, and, although the differences in rate do not vary greatly in the other counties, there is a slight trend downward from north to south.

PREVIOUS ANTI-MALARIA WORK IN WEST TENNESSEE

Most of the previous anti-malaria work undertaken in West Tennessee has been in and about cities. Surveys by representatives of the United States Public Health Service, the International Health Board or the State Health Department have been followed by campaigns to stop Anopheles breeding. These campaigns have usually been financed jointly by the above named organizations and by the cities concerned. They have usually been followed by a marked decrease in the incidence of malaria in the community. The permanence of these results has varied somewhat with the subsequent activity of the local authorities in continuing the measures at first applied. Draining and oiling have been the chief measures employed. The most extensive and successful work has been done in Shelby County, which contains the City of Memphis.

Screening of houses on a large scale as an anti-malaria measure was first undertaken in the State in 1927. A screen door factory was established in Dyersburg as part of the flood relief work of the American Red Cross, and 475 homes in Lake, Dyer and Lauderdale Counties were screened. This work has been expanded in Lake County in 1928, and is reported by Fullerton.[2]

PURPOSE AND METHODS OF STUDY

The purpose of this study was to secure definite data with which to evaluate the malaria problem of the State, and on which to base control activities. The Department of Preventive Medicine of Vanderbilt University was invited to join the State Health Department in making the study.

Lake County was selected as the headquarters for studying the problem and a laboratory was established at Tiptonville. The work was started on June 26 and continued until September 22, 1928.

The plan of procedure included:

(1) A study of the breeding places of *Anopheles quadrimaculatus* in Lake County.

(2) Ascertaining the distribution of the adults of this species in relation to cases of malaria.

(3) Surveys of homes and schools in Lake County in order to determine accurately the amount and distribution of malaria.

(4) Collecting adult anophelines and their larvae in Obion, Dyer and Lauderdale Counties.

(5) Surveys of schools for malaria in these counties.

(6) Collecting adults and larvae of non-malarial mosquitoes.

Anopheline mosquitoes and their larvae were studied by establishing catching stations in each of the counties named. These were visited weekly in Lake County by the laboratory staff, and in the other counties by the county sanitary inspector. All identifications were made by the Tiptonville laboratory. Adult anophelines were also caught in certain groups of houses where malaria surveys were made.

To determine the incidence of malaria, surveys were made of school children and of certain communities. The following procedure was carried out in most of these surveys. Each person was questioned by a physician as to a history of chills and fever during this year or in the past two years. A spleen examination was made by one of us (Meleney or Roberts). Children over twelve years old were usually excluded. The person examined was placed flat on the back with knees drawn up, and the examining hand placed directly on the abdomen, except in the case of a few girls on whom it was necessary to make the examination through one thin garment. If the spleen could not be felt with the child on his back, he was turned on his right side. Spleens were classified according to the method of Hackett,[3] P representing the palpable spleens which did not descend below the costal margin, and 1, 2 and 3 representing those extending between the costal margin and the umbilicus. No spleens were found which extended below the umbilicus. Blood examinations were made by the thick drop method. Except as indicated below, they were stained and examined by Mrs. Kiser, of the Tiptonville Laboratory, and were checked by Miss Aimee Wilcox, of Birmingham, Alabama. Anopheles mosquitoes were searched for with a flashlight in the houses visited and their number noted.

This procedure was carried out completely in three communities in Lake County, on one farm in Lauderdale County, and in schools in Obion, Dyer and Lauderdale Counties. In Lake County a blood survey of school children had been made in March, 1928, under the direction of the United States Public Health Service. This was repeated in September under the same direction, and these specimens were all stained and examined by Miss Wilcox. This survey covered practically all the schools of Lake County. In the other three counties it was necessary to limit the surveys to fewer schools in order to secure the information not afforded by a blood examination. In these surveys schools were selected from different parts of the counties in order to determine the distribution of the malaria problem.

RESULTS

Anopheles Breeding.—The entire area subject to overflow in the counties studied may be said to be suitable for the breeding of *A. quadrimaculatus*. This means that at different flood levels different places may meet the requirements of breeding places so that the studying of this problem requires observations over a long period of time and under all possible conditions. The most striking fact brought out by our observations was that, except in a few localities, larvae could be found only in small numbers, but that the total breeding area was very extensive. Except on parts of Reelfoot Lake and in certain swamps and ponds there is very little growth of algae. Algae are practically absent from the water in the overflow area. Floatage consisting of twigs is the main protection which larvae have from top-minnows, which are present in large numbers in all overflow water. The presence of these fish and the absence of algae are probably the reasons for the lack of more intensive breeding. In regions

not subject to overflow, suitable breeding conditions were furnished by swamps, pools in hill streams, and ponds for watering cattle. Fewer top-minnows and more algae aided breding in these places. After rains and in the latter part of the summer, unusual places were found to contain larvae. Around Tiptonville, from the middle of July to the middle of September quadrimaculatus larvae were found in the following places: in sloughs and bayous, in rain pools, in street ditches, in Reelfoot Lake, in borrow pits along the highway, in a cistern with clear water and partly covered, in a rain barrel, in a five-gallon can under a house, and in an unused cement watering trough.

A. punctipennis larvae were found mostly in streams, but also in street ditches and in pools about towns.

Adult Anopheles.—The large number of adults of *A. quadrimaculatus*, which were found almost everywhere in the counties studied, was in striking contrast to the difficulty of finding the larvae. In the overflow area they could be found in or around most of the houses, and in the hilly portions of the counties they were usually found at the catching stations. Adults of *A. punctipennis*, as is usually the case, were rarely found in or about human habitations.

Community Surveys.—In Lake County, surveys were made, with the cooperation of the County Health Officer, Dr. J. P. Moon, of three communities in the southern part of the County, to study the conditions associated with malaria. Two of these communities, Cottonwood and Hathaway, were in the region flooded during 1927, and had shown a high malaria blood index (25 and 35 per cent, respectively) among the school children in March, 1928. The third area, Madie, had been partly flooded, but had

TABLE 2

Malaria Survey of Communities, Lake County, Tennessee, July and August, 1928.

DISTRICT	Homes Examined	Number of Histories Taken	Malaria History		Number of Spleens Examined	Enlarged Spleens		Number of Blood Specimens	Organisms in Blood		Positive History, Spleen or Blood		Classification of Positive Spleen				Location of District	Homes containing A. Quadrimaculatus	
			No.	%		No.	%		No.	%	No.	%	P	1	2	3		No.	%
Cottonwood Homes	15	76	53	70	38	19	50	53	18	34	58	75	5	10	3	1	South border of county, land submerged during flood, several sloughs and water holes.	13	87
Cottonwood School	....	29	19	65	27	18	67	30	15	50	27	90	5	9	4	0			
Cottonwood Total	....	105	72	69	65	37	57	83	33	40	85	79	10	19	7	1			
Madie Homes	20	78	42	54	19	9	47	57	3	5	43	55	1	6	2	0	South central portion, land partly submerged during flood. One slough mostly dry. One bayou with water holes.	4	20
Madie School	....	55	39	71	42	26	62	51	13	26	43	78	9	11	6	0			
Madie Total	....	133	81	62	61	35	57	108	16	15	86	65	10	17	8	0			
Hathaway Homes	8	39	31	80	16	5	31	56	10	18	33	85	3	2	0	0	Southwest corner of county in bend of Mississippi River. Submerged during flood. Slough and large ponds always containing water.	5	63

shown a low blood index (2 per cent). The first two communities are each close to several sloughs, bayous and ponds in which quadrimaculatus larvae were found. The Madie district is farther from the river and contains one bayou which is usually dry and one which is continually flowing, but has several pools along its course which breed quadrimaculatus. All three districts had a few houses well screened, many poorly screened, and a few not screened at all. *Table 2* shows the results of these surveys. The Hathaway school was not surveyed at this time. It may be seen from the table that the evidence is nearly uniform in showing that malaria is an important health problem in these communities, and that it is most severe in the regions most favorable for quadrimaculatus breeding.

In Lauderdale County a survey was made of a large farm whose owner had arranged for its screening by the County Health Department. This survey was made with the cooperation of the County Health Officer, Dr. R. B. Griffin. The purpose of this survey was to get an estimate of the amount of malaria, previous to the employment of screening as a control measure, and as a basis for the efficient treatment of cases. A second survey next year should show the combined effect of these measures. The farm is situated in the northwest part of the County (*Map 4*). It lies mainly in the bottom land, but most of the homes are on the edge of the hilly region. The tenants are mostly negroes.

TABLE 3

Malaria Survey of Henning Farm, Lauderdale County, August 16-18, 1928

	No.	Per Cent	White	Col.
Homes visited	54		5	49
Histories taken	235		27	208
Positive histories 1927	105	45		
Positive histories 1928	50	21		
Spleen examinations	92			
Palpable	41	45		
Blood examinations	184		37	147
Positive bloods	41	22		
White	8	22		
Colored	33	22		
Houses containing A. quadrimaculatus	35	65		
Largest No. in 1 house	30			
Av. per positive house	7			

Table 3 shows that there is a high incidence of malaria among these people and that *A. quadrimaculatus* was present in most of the homes.

School Surveys.—In March and again in September blood surveys of the schools of Lake County were made under the direction of Mr. H. A. Johnson, of the United States Public Health Service, with the cooperation of the State and County Health Departments. We are indebted to the Public Health Service for permission to use the results of these surveys, which are shown in *Table 4* and *Map 2*. These surveys were intended to indicate the minimum and maximum incidence of malaria for the year. The results show an increase of positive bloods among the colored schools from 14.7 to 23 per cent, but among the white schools only from 10 to 12.2 per cent. It will be seen from *Map 2* that in the first survey the heaviest incidence of malaria occurred in the three white schools in the southern end of the County and that in the second survey all these schools showed a drop in incidence. Although the number of positives in any one school is too small to warrant definite conclusions, it is apparent that the September survey did not show the expected increase of malaria. This is probably due to the fact that the Lake County Health Department distributed a large amount of quinin in these schools in late August and early September because of the large number of cases of malaria present in the region. Teachers in some of the other white schools also distributed quinin to their pupils. The probability that this treatment was responsible for the lack of increase in the blood index

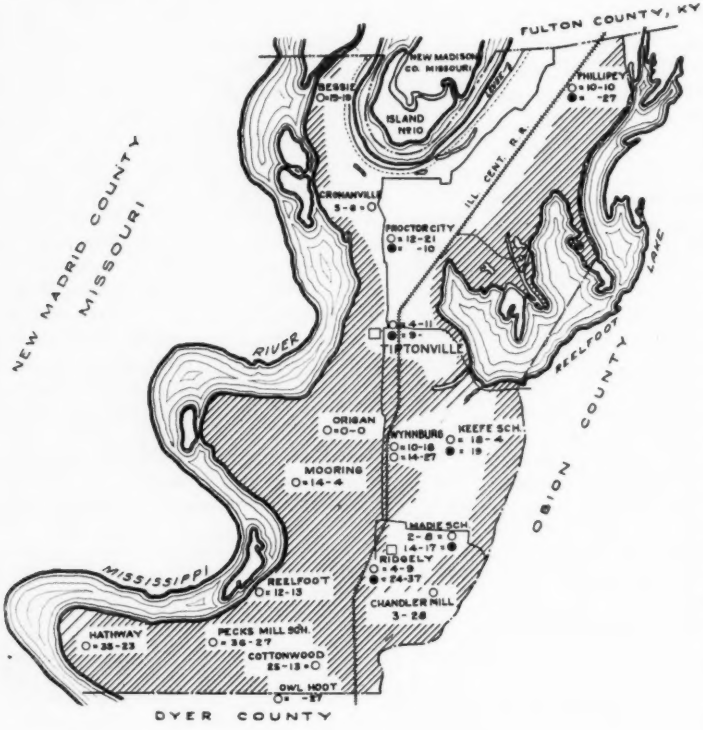
TABLE 4

Malaria Parasite Rate, Lake County Schools, March and September, 1928

White Schools	March Number Examined	March Number Positive	March Per Cent Positive	September Number Examined	September Number Positive	September Per Cent Positive
Bessie	32	6	19	36	7	19
Phillipey	28	3	10	45	6	13
Sheep Ridge	30	4	13	18	2	11
Cronanville	21	1	5	17	1	6
Proctor City	26	3	12	24	5	21
Tiptonville	116	5	4	156	17	11
Keefe	34	6	18	25	1	4
Wynnburg	31	3	10	63	5	8
Mooring	43	6	14	53	2	4
Madie	48	1	2	23	2	8
Ridgely	154	6	4	126	11	9
Chandler's Mill	33	1	3	25	7	28
Reelfoot	17	2	12	16	2	13
Peck's Mill	11	4	36	11	3	27
Hathaway	26	9	35	31	7	23
Cottonwood	37	9	25	30	4	13
Owl Hoot	....	....	....	22	6	27
Total	687	69	10.0	721	88	12.2
Colored Schools						
Phillipey	....	....	....	15	4	27
Proctor City	....	....	....	29	3	10
Tiptonville	75	7	9	not in session		
Organ	15	0	0	7	0	0
Keefe	27	5	19	not in session		
Wynnburg	22	3	14	15	4	27
Madie	21	3	14	18	3	17
Ridgely	58	14	24	38	14	37
Total	218	32	14.7	122	28	23.0

is borne out by the fact that in the surveys which our own staff made in the Cottonwood and Madie schools early in August an incidence of 50 and 26 per cent, respectively, were found. This is in marked contrast to the incidence of 13 and 8 per cent found in the September survey. Three other white schools in the southern part of the County also showed a similar drop in incidence.

A school survey was made in Dyer County during the fourth week in August, with the cooperation of Dr. O. F. Agee, County Health Officer. Six white and three colored schools were selected, located mostly in the bottom land where malaria was known to be prevalent, but with a few in the hilly region. Examinations of 411 children were made. *Map 3* and *Table 5* show the results of this survey. The County has an extensive area of bottom land, in addition to the valleys of two tributary rivers. The malaria incidence as shown by the blood survey and as emphasized by history and spleen records is highest in the portion of the bottom land which borders on the tributary rivers, is somewhat less on the bank of the Mississippi and is considerable in the hilly portion of the County where large streams are present. As there are no negro schools in the bottom land, a racial comparison of the incidence there could not be made. The Bonicord white and Tigrett colored schools, however, which are similarly situated, show equal blood indices. We feel that the malaria problem in Dyer County is of practically as great importance as that in Lake County and deserves vigorous attention.

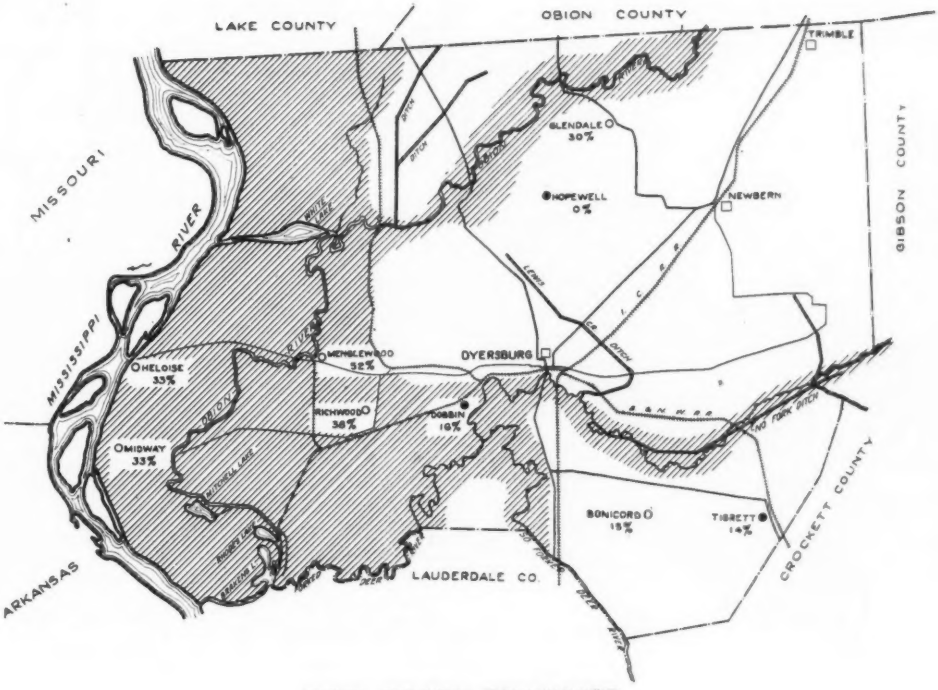


LAKE COUNTY, TENNESSEE

Map 2

Lake County, Tennessee, showing the land subject to overflow and the percentages of blood specimens positive for malaria in the school surveys of March and September, 1928. White circles represent white schools, black circles colored schools.

A similar school survey was made in Lauderdale County with the cooperation of Doctor Griffin during the second week in September. Four white and three colored schools were selected, and a total of 183 children were examined. If the 51 colored children on the Henning Farm between 6 and 16 years of age are included as another school, the total is 234. *Map 4* and *Table 6* show the results of this survey. The Ashport white school and the Henning Farm colored school are the only ones examined which are situated in or near the bottom land. The malaria incidence in these schools was high, but

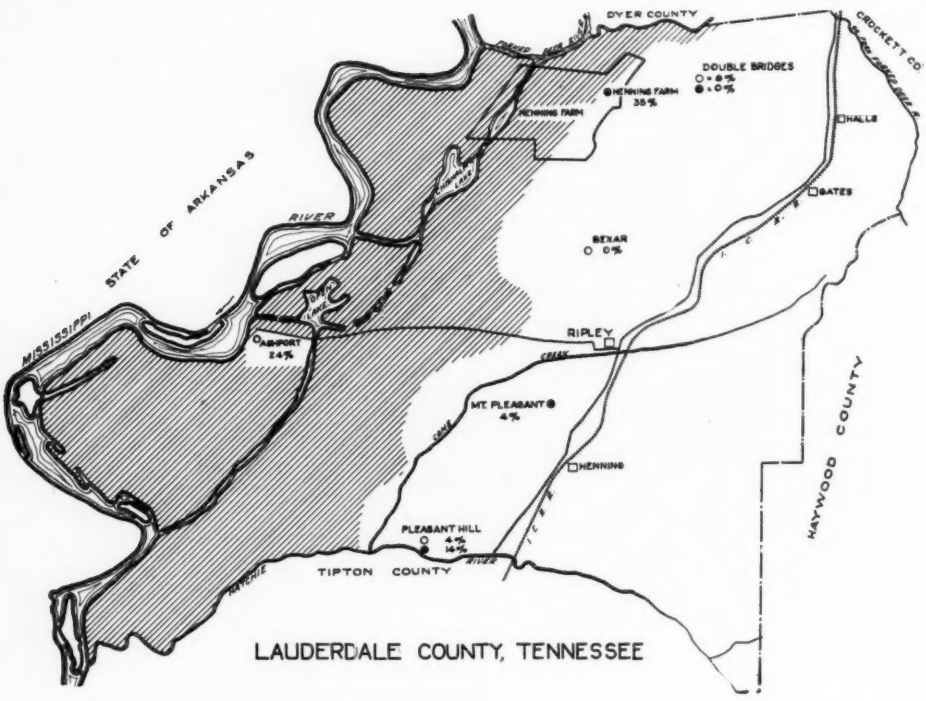


Map 3

Dyer County, Tennessee, showing the land subject to overflow and the percentages of blood specimens positive for malaria in the school survey of August, 1928. White circles represent white schools, black circles colored schools.

lower than in the worst schools in Dyer County. The incidence in all the other schools was comparatively low. *Map 4* shows that the bottom land in Lauderdale County is very extensive, but the tributary rivers are on the north and south borders of the County and have not many large branches invading the County. This may explain the lower malaria incidence in the hilly portion of the County than in the hilly portion of Dyer County. This survey was too small, however, to determine accurately the severity of the malaria problem, and a blood survey of all the remaining schools is now being made.

In Obion County a school survey was made during the last week of August with the cooperation of Dr. C. B. A. Turner, County Health Officer. Eight white schools were selected and a total of 311 children were examined. *Map 5* and *Table 7* show the results of this survey. Obion County represents in topography the hilly portions of Dyer and Lauderdale Counties. Although it borders Reelfoot Lake on the west, very little of the adjacent land is subject to overflow. The Obion River flows through the eastern part of the County, but flows somewhat more rapidly here than lower down in Dyer County. The only school showing a high blood index was the Stovall school, situated near the Obion River. The history and spleen data indicate a moderate incidence of malaria also in the Reelfoot and Wayside schools, the two most western schools of the County to be examined. These data are comparable to those of the hilly portion of Dyer and Lauderdale Counties. A



Map 4

Lauderdale County, Tennessee, showing the land subject to overflow and the percentages of blood specimens positive for malaria in the school survey of September, 1928. White circles represent white schools, black circles colored schools.

more complete survey of the schools in Obion County should be made.

Astivo-autumnal Malaria.—Out of a total of 230 positive blood specimens examined by the staff of the Tiptonville Laboratory during this study 46, or 20 per cent, showed organisms which could be identified as *Plasmodium falciparum*. Probably some others which could not be identified were also of this species. This indicates that the malignant parasite is still a factor to be reckoned with as a cause of mortality in this region.

NON-MALARIAL MOSQUITOES

The control of the non-malarial mosquitoes which feed on man is an important adjunct to anti-malaria work in this Country because it encourages local support of this work and is often demanded more urgently than disease control. *Table 8* shows the non-malarial mosquitoes collected during the summer's work, with their breeding places. As far as we can determine, this is the first systematic collection of the mosquitoes of Tennessee. It is felt that such a collection is distinctly worth while both as a scientific contribution and as a practical measure.

FUTURE PROGRAM FOR MALARIA CONTROL

This study has brought into sharper definition some features of our problem, while others require considerably more attention before they are understood. In the first place we now have definite data showing that there is a malaria problem in West Tennessee, and that it is most acute in the bottom lands and along the lower

TABLE 5

Malaria School Survey, Dyer County, Tennessee, August 22-24, 1928.

SCHOOL	Number Examined	Malaria History		Enlarged Spleen		Organisms in Blood		Positive History, Spleen or Blood		Classification of Positive Spleen				School Location
		No.	%	No.	%	No.	%	No.	%	P	1	2	3	
Glendale white	46	35	76	20	44a	14	30	35	76	5	9	5	1	10 miles N. E. of Dyersburg. Two miles from Obion River
Menglewood white	28	27	96	18	67b	14	52b	28	100	6	9	3	0	9 miles west of Dyersburg. In bottom land on Obion River
Richwood white	50	44	88	36	72	19	38	48	96	14	22	0	0	7½ miles S. W. of Dyersburg. Low land near Forked Deer River
Heloise white	57	54	95	33	67c	19	33	56	98	18	10	5	0	On Mississippi River
Midway white	45	38	84	21	60d	15	33	42	96	9	10	2	0	On Mississippi River
Bonicord white	48	28	58	20	42	7	15	34	71	11	8	1	0	8 miles S. E. of Dyersburg upland
Hopewell colored	56	15	27	1	2e	0	0	15	27	1	0	0	0	7 miles north of Dyersburg upland
Dobbins Grove col'd	37	18	49	6	16	6	16	19	51	3	3	0	0	4 miles west of Dyersburg. Low land near Forked Deer River
Tigrett colored	44	18	41	not	done	6	14	....	....	....	....	....	....	10 miles S. E. of Dyersburg upland

a Based on total of 45. One child not examined.
b Based on total of 27. One child not examined.
c Based on total of 49. Eight children not examined.
d Based on total of 35. Ten children not examined.
e Based on total of 52. Four children not examined.

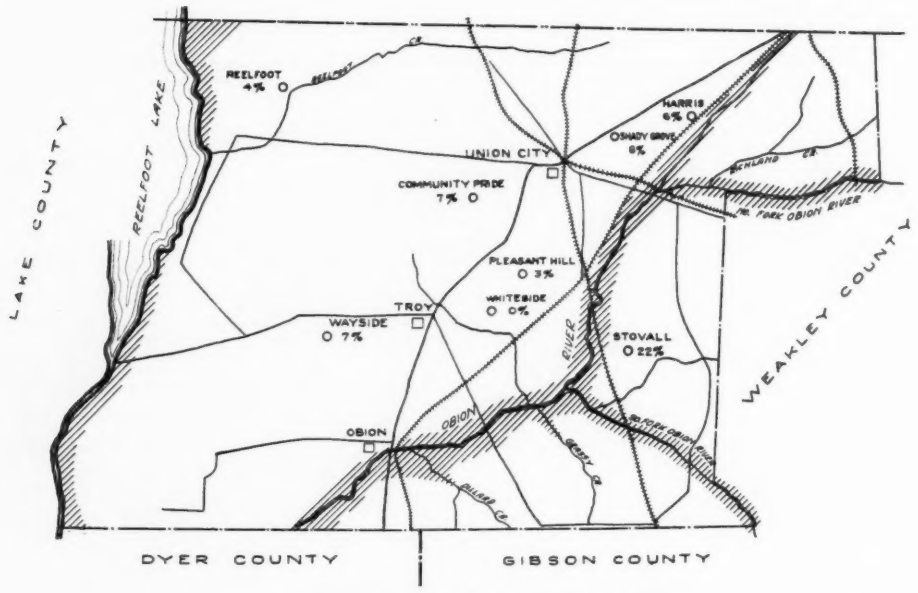
TABLE 6

Malaria School Survey, Lauderdale County, Tennessee, September 6-13, 1928.

SCHOOL	Number Examined	Malaria History		Enlarged Spleen		Organisms in Blood		Positive History, Spleen or Blood		Classification of Positive Spleen				School Location
		No.	%	No.	%	No.	%	No.	%	P	1	2	3	
Double Bridges white	24	11	46	10	42	2	8	13	54	5	3	1	*1	North part, hill region near creek
Bexar white	28	7	25	6	21.4	**1	3.6	10	36	4	2	0	0	Central part hill region
Ashport white	38	27	71	23	61	9	24	33	87	11	9	2	1	On Mississippi River
Pleasant Hill white	24	11	46	7	29	1	4	12	50	3	3	1	0	South part near Hatchie River
Double Bridges colored	24	4	17	0	0	0	0	4	17	0	0	0	0	North part, hill region near creek
Mt. Pleasant colored	25	1	4	1	4	1	4	3	12	1	0	0	0	South central part hill region
Pleasant Hill colored	21	9	43	3	14	3	14	9	43	3	0	0	0	South part near Hatchie River

*This boy a "physical wreck." No history, no organisms in blood.
**Moved out of river bottom this year.

FULTON COUNTY, KENTUCKY



OBION COUNTY TENNESSEE

Map 5

Obion County, Tennessee, showing the land subject to overflow and the percentages of blood specimens positive for malaria in the school survey of August, 1928. White circles represent white schools, black circles colored schools.

TABLE 7

Malaria School Survey, Obion County, Tennessee, August 23-30, 1928.

SCHOOL	Number Examined	Malaria History				Enlarged Spleen		Organisms in Blood		Positive History, Spleen or Blood		Classification of Positive Spleen				School Location
		1927		1928												
		No.	%	No.	%	No.	%	No.	%	No.	%	P	1	2	3	
Reelfoot	53	22	40.7	17	31.4	23	42.5	2	4	30	57	19	4	0	0	N.W. part, hilly, on creek, 4 miles from Reelfoot Lake
Wayside	32	7	21.8	8	25	12	37.5	2	*7	16	50	12	0	0	0	Central part, hilly
Commun'y Pride	68	14	20.5	9	13.2	15	22.5	5	7	22	32	8	5	2	0	Central part, hilly
White-side	20	1	5	3	15	2	10	0	0	3	15	2	0	0	0	Central part, hilly, 4 mi. from Obion River
Pleasant Hill	40	7	17.5	5	12.5	6	†15.7	1	3	10	25	5	1	0	0	Central part, hilly, 3 mi. from Obion River
Stovall	23	7	30.4	6	26.1	9	‡41	5	22	15	65	6	2	1	0	E. part, hilly, 2/3 mi. from Obion River
Shady Grove	22	3	14	2	9	4	18	0	0	5	23	4	0	0	0	N.E. part, hilly, 1½ mi. from Obion River
Harris	53	11	21	8	15	9	17	3	6	16	30	5	4	0	0	N.E. part, on Obion River

*Spleen examined in 31 only.
†Spleen examined in 38 only.
‡Blood examined in 22 only.

courses of tributary rivers. Lake and Dyer Counties are the most seriously affected. Estivo-autumnal malaria is shown to be present in considerable amount, making the danger of mortality still a menace to be considered. We now understand somewhat better the topography of the land in West Tennessee which is associated with the highest incidence of malaria; that is, the low lands along the tributary rivers, and regions rich in sloughs, bayous and flood-formed ponds. Drainage measures to improve the run-off from these regions, and provisions for maintaining what is accomplished by this drainage, are undoubtedly indicated as the line of attack against quadrimaculatus breeding, but the financing and supervision of such work is a problem in itself which cannot be quickly solved. The carrying out of flood control measures and an economic demand for agricultural drainage are related to this problem, and may help ultimately to solve it. Relatively small collections of water or larger lakes or streams which are navigable may be treated by larvicides, but most of the quadrimaculatus breeding areas included in this study are too extensive and too difficult to reach to be suitable for the use of larvicides. Airplane dusting with Paris green is, of course, far too expensive for use over this large area. These observations indicate that the breeding problem requires more study before we can determine what anti-larva measures should be employed.

We feel that county-wide screening may bring a greater amount of immediate relief than any other single anti-malaria measure. Whether it will be possible to educate the people to understand and carry out real mosquito-proofing of houses remains to be seen. If screening alone can succeed in diminishing the incidence of malaria to a low enough level, it may be that other measures will become less important. Re-surveys in screened and unscreened areas should provide considerable information on this question.

ACKNOWLEDGMENT

It is a pleasure to acknowledge the advice and assistance given during this study by Drs. L. L. Williams and M. A. Barber and Messrs. J. A. LePrince and H.

TABLE 8

Mosquitoes Collected in West Tennessee, 1928.

Mosquito	Breeding Places
1. Anopheles quadrimaculatus	Sloughs, lakes, ponds, ditches, rarely elsewhere
2. Anopheles punctipennis	Hill streams, ground-pools of various character
3. Aedes triseriatus	Tree holes
4. Aedes vexans	Clear sunlit pools, clear standing water
5. Culex quinquefasciatus	Dirty standing water, usually near habitations
6. Culex inhibitator	Similar to A. quadrimaculatus
7. Mansonia perturbans	Larvae attached to vascular roots of sedges at edges of lakes and ponds*
8. Megarrhinus septentrionalis	Tree holes*
9. Orthopodomyia signifer	Tree holes
10. Psorophora ciliata	Temporary pools of clear water
11. Psorophora columbiae	Ditches and pools
12. Psorophora cyanescens	Ditches and sloughs
13. Psorophora signipennis	Ditches and temporary pools
14. Psorophora howardi	Temporary pools
15. Psorophora varipes	Temporary pools

*Larvae not found in this study.

A. Johnson, of the United States Public Health Service; the cooperation of Mr. H. R. Fullerton, of the Tennessee State Department of Health, and Drs. J. P. Moon, C. B. A. Turner, O. F. Agee and R. B. Griffin and the staffs of their county health departments, and the faithful and efficient service of Mr. and Mrs. W. J. Kiser, of the Tiptonville Laboratory.

SUMMARY AND CONCLUSIONS

(1) A study of the malaria problem of West Tennessee, made in Lake, Obion, Dyer and Lauderdale Counties during the summer of 1928, showed a heavy incidence of malaria in the region which lies in the Mississippi River bottom and along the lower portions of tributary streams. Lake and Dyer Counties showed the heaviest incidence.

(2) Adults of *Anopheles quadrimaculatus* were found almost everywhere in the area studied. Breeding was found in varying amounts in regions subject to overflow, and in some hilly regions, but was, in general, more difficult to demonstrate than was the presence of adults.

(3) Concerted measures should be undertaken at once to control malaria in the areas of high incidence. Mosquito-proofing of houses is suggested as the measure most likely to produce prompt results. Where drainage is feasible it should also be undertaken.

(4) Further study of quadrimaculatus breeding is necessary in order to devise methods of control in extensive breeding areas unsuited for the use of chemical larvicides. A study should be made of the feasibility of cooperative efforts in malaria control, flood control and agricultural drainage.

(5) Twenty per cent of the positive blood specimens found in this study contained *Plasmodium falciparum*.

(6) Fifteen species of mosquitoes were collected during this study. Measures to diminish the incidence of the non-malarial mosquitoes will be a valuable adjunct to malaria control work.

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DISCUSSION (*Abstract*)

Dr. Paul S. Carley, Belzoni, Miss.—There are two points of interest that I might add in the discussion of this paper: first, the breeding of *Anopheles quadrimaculatus* in small containers seems to be limited to the Delta of Mississippi and Arkansas. Second, in regard to the difficulty of finding anopheline larvae: in areas like the one in which Doctor Meleney was working there are large water surfaces that will permit anopheline breeding. The difficulty in finding larvae seems to be due to the dilution of a large number of larvae over a larger area of water. In the Delta of Mississippi, it is difficult to find larvae at any time of the year and almost impossible after November 1.

I should like to ask Doctor Meleney what differences were noted in colored and white spleen rates, and in colored and white blood rates.

Dr. M. A. Barber, Greenwood, Miss.—We also find that *A. quadrimaculatus* in the Mississippi Delta is very adaptable as regards its breeding places. It seems that almost any water in this region at all fit for anopheles may at one time or another harbor *A. quadrimaculatus*. Various species of Anopheles show certain preferences in their choice of breeding places, but larvae of *A. quadrimaculatus* are found in a great variety of waters in the Delta.

Dr. Meleney (closing).—I do not believe that the absence of the rise in incidence of malaria shown in my paper by the blood survey of school children in Lake County in September was due to the screening carried out during the summer.

Doctor Carley asked about the relative incidence of malaria in white and negro schools, particularly in relation to splenic enlargement. We have the following data on white and colored schools similarly located:

Schools of Same Locality	County	School	Percentage Positive		
			Malaria History	Spleen	Blood
White	Dyer	Bonicord	58	42	15
Colored	Dyer	Tigrett	41	*	14
White	Lauderdale	Double Bridges	46	42	8
Colored	Lauderdale	Double Bridges	17	0	0
White	Lauderdale	Pleasant Hill	46	29	4
Colored	Lauderdale	Pleasant Hill	43	14	14

*Not done.

We got a very distinct impression that the spleens were not as much enlarged in colored children as in white children.

MOSQUITO CONTROL IN LAKE COUNTY, TENNESSEE: A COUNTY-WIDE SCREENING PROGRAM*

By H. R. FULLERTON,†
Nashville, Tenn.

The preceding paper[1] has set forth facts concerning the mortality incidence particularly in Western Tennessee. It has been clearly shown that Lake County has sustained a heavier mortality experience than any other section of the State. Among the several control measures instituted in this as well as other counties was that of house screening.

DESCRIPTION OF AREA

Lake County is situated in the extreme northwestern corner of the State; is bounded on the west by the Mississippi River; on the north by Kentucky; on the east by Reelfoot Lake, and on the south by Dyer County. The County is 122 square miles in area. The width varies from three to eleven miles; the length is approximately twenty miles. A large number of sloughs are found in the County. Several of these are of considerable size and contain water the year round, furnishing ideal breeding places for mosquitoes.

The farm land of the County is owned principally by about fifteen individuals. The total number of property holders is approximately 125. It is stated that one person pays one-seventh of the entire taxes of the County. Farming is conducted on a rather intensive basis. The vast majority of all farms is cultivated by means of wage hands and "share crop tenants."

According to the 1920 census there were 9,208 people in the County. In the rural sections exclusive of the two principal towns, namely, Ridgely and Tiptonville, the population eight years ago was 7,248. The increase since that time has probably not exceeded over four or five hundred. The number of houses in the rural sections is estimated to be between seventeen and eighteen hundred.

1927 SCREENING PROGRAM

During the year 1927 there were 165 houses screened by the American Red Cross, the State Department of Public Health and the United States Public Health Service.

THE PRESENT 1928 PROGRAM

Early during the year the larger land owners in Lake County were invited to a meeting. In attendance were several members of the County Court. At this meeting the County Anti-Malaria Committee, consisting of five principal land owners, was formed, a committee representative being chosen from each section of the County. This Committee provided for a rotating fund of $600.00 and a ninety-day credit allowance. This was equivalent to approximately $2,000.00, total assets to be used by the Committee in the manufacture of screen doors. A factory site in Tiptonville was selected; and equipment furnished by the Red Cross during the 1927 campaign was installed.

Detailed House Survey.—A careful study was made of each residence in the County. A careful record of each house, showing location, owner, agent or tenant; number and sizes of doors and windows was made. This record also shows cost data and indicates whether the owner would be responsible for the hanging of the doors and tacking the screening on the windows, or whether this responsibility would be delegated to the Committee.

Manufacturing of Doors.—The doors were patterned exactly in accordance with the design described by the United States Public Health Service.[2]

A door identification card was developed. The data entered thereon was name of owner, tenant or agent, size of door, and relative position to the door on the house, and whether it would swing left or right. This record carried the house number, indicating the exact location of the house in the County. This record was attached to the inner side of the top cross piece just as the door was started on its course of assemblage.

Other Records.—A cost sheet was developed and careful records kept as to the itemized cost of screening each house, as well as the total for all houses screened. This information in detailed statement form was not given to the owner except upon request. Statements were rendered in the gross. The average cost, as shown in *Table 1*, per screen door was $1.50, f. o. b. factory.

Labor Cost.—It was found necessary to employ a competent shop foreman. Under him was

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*Read before National Malaria Committee (Conference on Malaria), meeting conjointly with Southern Medical Association, Twenty-Second Annual Meeting, Asheville, North Carolina, November 12-15, 1928.

†From the Division of Sanitary Engineering, State Health Department.

placed a number of colored laborers. This, however, was not a satisfactory arrangement, high school boys being substituted for these later. This new arrangement proved to be much more satisfactory. On the basis of their ability to produce ten finished doors daily the boys were paid $2.00 per day each, the labor cost per door, therefore, being 20 cents.

Other Costs.—Cost of survey of correct hanging of doors; attaching window screening and other mosquito proofing; periodic inspection and instruction as to the proper use of the screens were not added to the owner's bill. The Committee did not assume responsibility for delivery of the doors, the owner being notified promptly on the completion of his order for doors.

Results.—Table 3 sets forth in detail the number of houses screened during 1928 in Lake County; also the number of schools, churches, camps and the like in which screening was effected. Much use was made during the campaign of the two weekly newspapers of the County. Each of these carried in almost every issue some data concerning the advantage of screening and through this, as well as other methods, much interest was aroused in the County.

Not only were the screens properly installed, but the members of the family carefully advised as to the proper use of these screens. The freedom from mosquitoes as the result of the proper installation and use of the screens was one of the principal aids toward the expansion of the program.

CONCLUSIONS

(1) In a county-wide screening program where property owners are to pay the cost too much attention cannot be paid to details, item costs, education, and quality of work done.

(2) The season's needs should be anticipated as closely as possible and the wholesale company from whom you expect to buy materials informed thereof.

(3) A stock inventory should be taken daily.

(4) Doors of a design of known strength and durability only should be used.

(5) If additional mosquito proofing is necessary this phase of the work should be vigorously prosecuted until it is completed at every home.

TABLE 1

ESTIMATE OF COST OF A SCREEN DOOR

Average Door 32″x78″

Galv. iron corner bracing—24g—30″x96″ @ $1.26	$ .095
*Screen wire 15.1 sq. ft. @ 3c	.434
*Lumber 7.63 bd. ft. & $72.50 per m and 0.3 m casing strips @ $.35 m	.564
Corrugated fasteners	.005
Labor	.200
Hinges @ 10c pair	.100
Screws @ 20 gross	.016
Tacks @ 17c lb.	.010
Nails @ 6c lb.	.009
Springs No. 5 @ 4c	.040
Pulls and screws @ 2c	.020
Freight on screen wire and hardware	.007
	$1.50

*These items include 5% for waste.

TABLE 2

MATERIAL AND COST DATA

Doors

Doors average in size 32″x78″.
Number of doors per house (253 houses), 2.8.

Windows

Number of windows per house (average 100 houses) 4.76.
Average amount of wire per house for windows (includes 5% for waste), 59.5 sq. feet.
Average amount of wire per window, 12.5 sq. feet.

Average Cost Screening One House

Cost tacking wire on one window (17 houses)	$ .115	
Cost of tacking wire on one house—4.76 windows		.55
Cost of wire for one window @ 0.3c	.375	
Cost of wire for one house—windows		1.78
Cost one door at factory	1.50	
Cost doors for one house—2.8 doors		4.20
Cost of hanging one door	0.8	
Cost of hanging doors one house—2.8		.22
Transportation of doors		....
		$6.75

TABLE 3

SCREENING IN LAKE COUNTY, TENNESSEE, TO NOVEMBER 1, 1928.

Doors

Doors made for homes in Lake County	2152
Doors made for Camp Markham (Boy Scouts)	167
Doors made for Lauderdale County	167
Doors rescreened for Lake County	58
Doors made for commercial establishments	4
Doors made for churches	2
Doors made for county schools	36
Total doors	2457

Screen Frames

School house window frames	211
Frames for tents, Camp Markham	144
Churches	8
Houses	7
	370

Homes Screened

Homes screened, Lake County, 1928	880
Homes screened 1927, Lake County	165
Total	1045
Estimated per cent of Lake County homes now screened	59.7

HOUSE SURVEY AND RECORD SHEET

LAKE COUNTY ANTI-MALARIA PROJECT

Dist. No.....Road No.....House No.....
Owner .....
Agent .....
Tenant .....
House measured by .....Date.....

Doors

Number of doors.....Date made.....
Date doors left factory .....
Is Health Unit to hang doors? Yes.....No.....
Time hanging doors, hours.....
Amount .....Foreman's initials.....

Windows

Number of windows.....Total sq. ft. screen required.....
Is Health Unit to furnish window screen? Yes.....No.....
Is Health Unit to put up window screens? Yes.....No.....
Time hanging windows, hours.....
Amount .....Foreman's initials.....
Were window screens sent out with doors?.....
Yes..... No..... Sq. Ft.....
Is house completely screened with 16 mesh?
Doors ..... Windows .....
Is other mosquito proofing satisfactory?
Yes ..... No..... Remarks.....
Inspected by .....

Front

Number of chimneys.....
Number in family.....
Number had malaria, 1927.....
Number had malaria, 1928.....

.....
Signed.

Be sure and fill in each item at time work is done.

REFERENCES

1. Meleney, H. E., and Bishop, E. L.: Observations on the Malaria Problem of West Tennessee. S.M.J., 23:382, April, 1929.
2. Volume 42, No. 16, April 22, 1927.

DISCUSSION (*Abstract*)

Dr. L. L. Williams, Jr., Richmond, Va.—It should be noted that before the screening work was commenced malaria indices were taken by history, spleen, and blood. After the screening was completed, similar indices were taken. The effort here made was good; it was as good as any county can expect from its health department. In subsequent years indices will be repeated. This study will not only indicate the measure of protection afforded by county-wide screening, but will give added data on the relative efficiency of the three types of malaria index in measuring the rise or fall of the infection.

Dr Henry E. Meleney, Nashville, Tenn.—I think I ought to say what I know is also in Mr. Fullerton's mind, namely: that the screening work in Lake County has only had its beginning. In the houses that are screened, mosquito-proofing has not yet been thoroughly carried out. Unless that is done, the screening loses a great part of its value. That is to be done during the winter, and next summer we are going to be able to measure by means of surveys the effect of the screening.

OIL MIXTURES AND OIL EQUIPMENT FOR ANOPHELINE LARVAE CONTROL OF IMPOUNDED AREAS*

By L. M. CLARKSON,†
Atlanta, Ga.

Since little more than a quarter of a century ago, when oil was first used for control of mosquito larvae, very few data have been presented on the value of various grades and mixtures of oil for this purpose. There has also been a limited understanding of the effect of various oil films upon larval life. Until recent years oils for this purpose were used almost exclusively on small areas of water, not necessitating the factor of economy. For such use there has been an inclination to accept almost any distillate of crude petroleum of light specific gravity which would spread well on the water.

In recent years it has become necessary to control mosquito breeding on large hydro-electric impounded areas. Due to the large quantity of oil required and the expensive oiling equipment necessary, there has developed a realization of the necessity for definite oil formulae, as well as standard equipment for application. On account of the extensive development of hydro-electric power in the Southeast, where malaria is prevalent, there are few sanitary problems of greater importance than control of production of anopheline mosquitoes on impounded waters.

The following information represents only an experiment and is presented as a step to what should be accomplished by further experiments with various portions of certain grades of oils and the mechanical equipment for application. The experiment was in connection with an impounded area of about 7,000 acres. The area was first cleared of all vegetation. Before oiling was begun it was necessary to provide equipment, material and personnel for oil spraying.

At the start of the work a mixture of fuel oil and kerosene was used in a number of different portions, 25-75, 30-70, 40-60, and 50-50, none of which was found to film effectively or have

*Read before National Malaria Committee (Conference on Malaria), meeting conjointly with Southern Medical Association, Twenty-Second Annual Meeting, Asheville, North Carolina, November 12-15, 1928.

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the required toxic effect. Then 1100 gallons of transil oil was acquired, which proved to have all of the qualities for spreading as well as a slight toxic effect, and when mixed 50-50 with kerosene gave excellent results. (Transil oil is a very highly refined oil used in transformers. Even the waste is of too high value to be economical.) When the transil oil was exhausted oil was again used and the breeding curve took an upward slant. Then there were secured from the Standard Oil Company samples of plain black oil, paraffin oil and distillate oil. The best results were obtained with a mixture of 20 per cent black, 20 per cent kerosene and 60 per cent paraffin oil: the black oil for maintaining the film, the kerosene for toxic effect, and the pariffin for spreading. The presence or absence of breeding was checked by a dipping crew which followed the spray crew three days later, checking the places where breeding had been heavy.

While fuel oil was being used control was only fair. When transil oil was used the breeding was reduced about 75 per cent. On return to fuel oil the breeding increased. When paraffin oil was used there was almost complete control after the second round. The checking crew then checked one day ahead of the spraying and their findings showed larvae too small for identification and in most places no breeding at all.

The following shows the cost of malaria control work for the year 1927:

Total cost for equipment	$7,688.00
Take 20 per cent for the year 1927	$1,533.00
Total cost of labor for five months	6,400.00
Total cost of spray oil, gas and supplies	1,979.20
Total	$9,912.20

The total length of the shore line was 156 miles, and 22 oilings of 3½ days each were made for the season.

Six hundred fifty-five and one-half gallons of oil were used for each round of oiling.

The average width of the oil film was fifteen feet.

COST OF OIL

The number of acres oiled per round was 283.5, and amount of oil per acre 2.5 gallons. At a cost of 11 cents per gallon for oil this gives a cost of 27.5 cents per acre per round of oiling, or $6.05 per acre per season.

The cost of oil per mile of shore line per round was 46.2 cents, or $10.16 per mile of shore line per season.

GRAND TOTAL COST

The grand total cost per acre per season was $35.00.

The grand total cost per mile of shore line per season was $63.34.

Because of the great length of shore line, necessitating a supply barge and operation far from base and liberal allowance for elaborate equipment, the unit cost figures herewith should be considered as maximum rather than minimum. On smaller areas where the supply barge could be dispensed with and supply stations established on the shore, this unit cost could no doubt be considerably lowered.

As an appendix there is herewith attached detailed cost of equipment, labor and supplies:

EQUIPMENT

1 supply barge 40x18x4'6" draft	$2,600.00
1 propelling engine 26 H.P	150.00
1 Worthington feather valve air compressor	325.00
1 novo vertical gas engine, 9 H.P	275.00
1 air receiving tank, 250 lb. pressure, 42"x96"	230.00
4 82-gallon gas tanks	100.00
8 2½ H.P. Johnson outboard motors	1,008.00
Repair parts for Johnson motors	600.00
5 spray boats 16'0"x3'9" beam, each equipped with 1 82-gallon oil tank, spray nozzle and metal hose	300.00
	5,588.00
2 motor boats, 1 25 ft. and 1 20 ft., inspection, etc.	2,100.00
Total	$7,688.00

LABOR

1 supervisor at $150.00 per month	150.00
1 assistant supervisor at $100.00 per month	100.00
5 operators at $80.00 per month	400.00
3 operators at $70.00 per month	210.00
4 laborers at $2.50 per day (per month)	240.00
1 mechanic (part time) $6.00 per day, 30 days	180.00
Per month	$1,280.00
For season	6,400.00

SUPPLIES

14,420 gallons of spray oil at 11c per gallon	$1,586.20
960 gallons of gas at 20c per gallon	193.00
Tools and miscellaneous supplies	200.00
For year	$1,979.20

PRACTICAL APPLICATION OF PARIS GREEN AS A LARVICIDE FOR ANOPHELES LARVAE ON AN IMPOUNDED LAKE IN ALABAMA*

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Petroleum products, chiefly kerosene and black oil, have had almost universal application as a larvicide in the control of anopheline mosquito breeding on newly impounded waters in Alabama. The use of this larvicide has generally met with success on lakes impounded strictly in accordance with the State regulations governing impounded waters. The principle requirements are that the basin be cleared before impounding and the waters stocked with gambusiae.

Within the last few years no less than ten major lakes have been impounded in the State. The efficiency of oiling methods and equipment has progressed rapidly since the first larvicidal control work of note was undertaken on Lake Mitchell of the Alabama Power Company in 1923.

The high pressure pneumatic method of oil spraying was developed in 1923 on the Golden Bridge Pond of the Houston Power Company. To meet certain conditions which were not favorable to this method, a machine was developed on Lake Martin, of the Alabama Power Company, which delivered a large stream of water into which was introduced the required amount of oil, the oil-water method.

Conditions Leading to the Use of Paris Green on Lake Martin.—Notwithstanding the rapid improvement in methods of oiling, it developed during the season of 1927 that certain areas on Lake Martin were very difficult if not impractical to control through oiling.

The basin was cleared prior to impounding. However, some two years' time was required for clearing operations which gave rise to a considerable second growth of sprouts, bushes and weeds, before impounding could be accomplished. Some of the most important areas were improved by subsequent reclearing.

Impounding was begun early in 1926, proceeding slowly during the breeding season of 1926 and up until the latter part of the 1927 season. The slowly rising water into territory previously unflooded gave rise to conditions particularly suitable for *A. quadrimaculatus* production *en masse*. That portion of the shore line which was more or less open was fairly easy of handling. There were, however, certain larger flat areas most difficult to reach and oil effectively. In addition, algae were found to be growing profusely in the wind-protected areas which added materially to the difficulty of reaching the larvae with a toxic oil film.

The control season ended abruptly during the latter part of August, when use of the stored water for electrical development was begun. With the lowering of the lake level a sharp decrease in adult *A. quadrimaculatus* station counts resulted. After three weeks practically no adult mosquitoes could be found.

In view of conditions encountered during the season of 1927, it was agreed between the Company and the State Board of Health that the use of paris green would be attempted on certain areas during the season of 1928. Oiling equipment would be used where effective.

Selection of Equipment and Material for Paris Green Application.—Literature on the subject of paris green was studied carefully. Barbour,[1] Boyd,[2] Hackett,[3] King,[4] Williams,[5] LePrince[6] and others reported successful use of paris green as an anopheline larvicide. The application had been accomplished by means of a dust cloud produced on the windward side of the area. This floated over the breeding ground and deposited paris green. Distribution has been by hand, by hand dust guns, and by airplane. The paris green had been mixed with some inert dust in varying proportions from 1 to 50 per cent, depending on the method and rate of application. From one-half to one pound of paris green per acre had been used for successful destruction of larvae.

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*Report to National Malaria Committee (Conference on Malaria), meeting conjointly with Southern Medical Association, Twenty-Second Annual Meeting, Asheville, North Carolina, November 12-15, 1928.

*This work was carried out by the Alabama Power Company, cooperating with the Alabama State Board of Health. The experiment was attempted at the suggestion of Mr. G. H. Hazlehurst, Chief Sanitary Engineer, Alabama State Board of Health, whose criticisms have been available and most helpful at all times.

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††Supervisor, Sanitation and Malaria Control, Alabama Power Company.

It was realized that the methods of distributing dust which had been used in the past at other places would not be applicable on Lake Martin. Hand methods of distribution would be inadequate. The use of airplanes was not considered economically sound or adaptable to the work due to the basin characteristics. There were hundreds of bights, of varying lengths and widths, enclosed by steep, rolling hills. The breeding areas were widely separated over a large territory. The shore line was ever changing.

This is the largest lake in the State. A conception of its extent may be had when it is stated that at maximum elevation an area of 40,000 acres is submerged, forming a shore line estimated at 700 miles. The project might be termed a storage reservoir, water being impounded during the rainy season and used during the dry season.

Power dusters had not been used previously for this type of work. Various makes were tested early in the winter of 1928. Experimental equipment was mounted on a boat and tried before the breeding season. It gave full promise of success. For handling areas which could not be reached by the power machine, hand dusting would have to be used. Various types of hand dusters were, therefore, tried out.

After considering the merits and adaptability of three makes of power machines, the Niagara F-27 machine,[7] with an 8 horsepower engine, was selected to be supplemented by the Fiasco knapsack hand dusters.[8] The fan blower type hand machines produced the more suitable dust cloud, but were more tiring to operate than the knapsack bellows type.

Following the preliminary study, the manufacturers of dusting machines, dusts and paris green were conferred with in reference to the character of the dust. Road dust, kaolin, powdered soapstone and lime were considered. After investigating costs and adaptability it was decided to use soapstone rather than some of the other carriers for the following reasons:

(1) It was available in any quantity on short notice.

(2) Uniform in quality.

(3) Most economical under the conditions.

(4) Could be obtained from the manufacturer, machine mixed with paris green, insuring uniform mixing.

(5) Appeared to float and carry in a dust cloud with the paris green. Location of the settlement of the dust cloud would, therefore, be a true indication of where the paris green had been applied.

(6) Least absorbent.

(7) Being floatable, hope was entertained that it would mechanically assist in keeping the paris green afloat for a longer time than might be secured through use of a readily sinkable dust.

A contract was later given to a chemical house[9] in Birmingham for furnishing the paris green soapstone mixture in 50-pound paper sacks.

The paris green[10] to be used was guaranteed to contain a minimum of 50 per cent arsenious oxide ground to such fineness as to pass a 200-mesh sieve.

Application of Paris Green as an Anopheles Larvicide on Lake Martin.—Routine inspection for larvae and adults was begun on May 1. Due to heavy rainfall, the lake became completely filled before *A. quadrimaculatus* production began. With some few feet fluctuation it remained practically full throughout the summer. From a standpoint of mosquito production, the shore line improved throughout the season. Conditions most favorable for anopheline breeding as encountered in 1927 did not obtain to such an extent in 1928 except for possibly a short period during the earlier part of the season. Any conclusion drawn from subsequent observations must necessarily be considered along with the fact that the work was done on a lake sufficiently clean, with few exceptions, for control through oiling.

During the first week in June sufficient *A. quadrimaculatus* larvae were found to warrant the beginning of control operations. The dusting unit was assigned sections of the shore line which had previously proved most difficult and expensive of control through oiling. The complete unit consisted of one power duster mounted on a boat propelled by an outboard motor. Two men were required for its operation. Accompanying this power duster was a small boat carrying the foreman of the unit and two laborers equipped with hand dusters for treating areas which could not be reached by the power machine.

Shortly after the dusting unit had been placed in service observations were made on its operation and effectiveness. Records of previous work done elsewhere gave one pound of paris green per acre as sufficient for complete larvae destruction. The first check showed that a 1 per cent mixture did not contain sufficient paris green to reach all areas with one pound per

acre at the rate of dust application adopted. As close as might be estimated, a 5 per cent mixture appeared suitable. In this connection it might be stated that it is very difficult to estimate the average amount of dust reaching an irregular area. With the slightest breeze the dust would often be carried far beyond the intended points of application. In fact, the chief difficulty encountered in the work was to get settlement of the dust where desired.

Areas were checked before and after dusting, and mortality was found practically complete in some areas, while in others larvae reduction was not more than 50 per cent. The dust was tried in pans and found to kill practically 100 per cent in less than six hours. Areas were selected and the dusting continued until there remained no doubt that an amount of paris green in excess of one pound per acre had been applied. Uniform mortality did not result in all places.

Study and Experiments to Determine Reasons for Non-Uniform Larvae Reduction on Lake Martin Through Use of Paris Green.—As an explanation of the failure to secure uniform results, the following possibilities presented themselves:

(1) That the paris green being used was not sufficiently toxic. In other words, the arsenic oxide content was below that guaranteed and found essential for such work.

(2) That the paris green was not of the proper grade as to size of particles.

(3) That the powdered soapstone, used as a diluent, remained on the surface and was perhaps being eaten by the larvae, which lessened their chance of obtaining a lethal dose of paris green.

(4) That an insufficient amount of paris green was being applied to certain areas.

(5) That the paris green, through sinking quickly or being carried away by wind currents and wave action, or for other reasons, was not being held in contact with the larvae for a sufficient length of time to enable them to obtain a lethal dose.

As to the possibility of the paris green's not being sufficiently toxic, the dust was applied to larvae in pans with almost complete mortality in about two hours. A sample of the paris green was submitted to Dr. B. B. Ross, State Chemist, who found the specimen contained 52.36 per cent arsenic trioxid (As_2O_3).

Boyd[2] reported that the color of an unsatisfactory lot of paris green, purchased and used in South America, was pale green, while that of a satisfactory lot, purchased later and used successfully, was a deep emerald green in color. The paris green used on Lake Martin had the deep emerald green color.

Notwithstanding these reports and observations on the quality of paris green being used, it was decided to compare it with the product from other manufacturers by actual field tests, records of which are given on tabulated form on another sheet.

The size of the grains was tested in several ways. Of several samples given, the size test recommended by Hackett[3] as representing a satisfactory paris green, all passed completely through the 200-mesh sieve. Samples given the cylindrical tube test, as representing a satisfactory paris green as to size of particles, conformed to the test. This test is quoted as follows:

"A rough criterion is the tendency of too fine a powder to clump in small masses when rotated in a test tube. The grains of a coarser powder will roll separately one over the other without agglomerating and in a small tube will assume a plain surface to the angle of rest."

The paris green from four manufacturers was also examined under the microscope. The particles in all appeared to have considerable variations in size. In a single sample would be found particles ranging in size from very fine to very coarse. Subjecting a sample to prolonged grinding in a mortar seemed not materially to increase the fineness of the particles as observed under the microscope.

One manufacturer,[11] whose product (brand C given in the tabulation), is reported to have had wide use on such work in the past, stated that his paris green was ground sufficiently fine to pass almost entirely through a 300-mesh sieve.

The record of a test using paris green, passing a 130-mesh sieve and retained on a 200-mesh screen, is given in the tabulation of experiments.

As to the proper characteristics of the diluent it might be stated that highly satisfactory results were reported by Williams,[5] LePrince[6] and others through the use of paris green and soapstone in the airplane distribution work at Quantico and Bamberg. However, a much greater per cent (minimum 25) was used in the airplane work than was used on Lake Martin (maximum 5 per cent).

Comparative tests were made on larvae under natural conditions to arrive at the possible difference in effectiveness using soapstone and a readily sinkable carrier as kaolin or hydrated lime. The record is given in the tabulation of experiments. In 1922 Barbour and Hayne[12] advised against the use of flowers of sulphur, stating that because so large a portion of it re-

mained floating it was ingested with the paris green, which was then too much diluted.

It is difficult to determine accurately the amount of paris green which is applied to irregular areas as found in field practice. However, judging the application on the lake by comparison with the application made to measured areas it is estimated that the average dosage was one pound per acre, although some areas may not have received so much.

The possibility of the paris green's not being held in contact with the larvae under the conditions appeared to be chiefly influencing the results. A review of the literature showed that previous applications of paris green had been almost exclusively in areas covered solidly with brush, trees and aquatic growth. The breeding areas in comparison on Lake Martin were more or less open and subject to agitation with little of the aquatic growth found in some old ponds and natural bodies of water. Again after the dust cloud had settled on the surface of the water in these more or less open areas it was very often blown aside by wind currents. Added to this was the wave action from the distributing boat, which undoubtedly increased the possibility of the paris green's being sunk or drifting aside before it could be ingested by the larvae.

In an effort to obtain an answer to some of the possibilities considered, which were pressing, a series of experiments were made in the vicinity of Montgomery and elsewhere.[13]

A number of the tests were made on an old ditch near Montgomery, where heavy anopheline breeding was found. This ditch was located in a swamp and averaged some twelve feet in width. Water stood to a depth of about two feet. The water surface was unusually clean except for a thin rim of vegetation, leaves, and floatage along the edges. The flow of water was practically negligible. Twenty fourth-stage larvae were taken from the ditch about the time the tests were begun and identified as follows: 1 *A. quadrimaculatus;* 12 *A. punctipennis;* 7 *A. crucians.*

The alkalinity of the water by the methyl orange test showed 12 parts per million.

In some of the tests microscopic examinations were made on the dust films taken from the water's surface. In all cases a greater or equal density of paris green for any given length of time was found in films taken from the pans than was found on films taken from the breeding areas.

In experiment No. 11, given in the tabulation, a mortality of 96 per cent resulted in the accompanying pan test with only a 36 per cent mortality being observed in the breeding area. In this particular experiment dust films were taken at thirty minute intervals and examined under the microscope for paris green. The paris green distributed over the area sank rapidly with a greater percentage going down immediately following the application. On the other hand, the paris green on the surface of the water in the pans appeared undiminished after two hours. Only one particle of paris green per microscopic slide could be found in the film from the breeding area after this length of time. This observation offers an explanation for the usual greater mortality in the pans over that found in the breeding area. The influencing factor appears to be the variable water tension holding the particles afloat. This tension evidently varies with different bodies of water. In the successful experiments, Nos. 17, 18, 19 and 20, practically equal densities of paris green particles were observed on the surface of the water, in the pans, and on the breeding areas at all intervals of time up to two hours. In other words, the paris green applied to these areas remained afloat for a sufficient length of time for the larvae to obtain a lethal dose. Our observations in these experiments indicate that with an increase in the density of floatage and growth the water tension increases with a corresponding increase in the probable effectiveness of paris green.

During the tests it was noted that in some cases where a readily sinkable diluent was used as kaolin or hydrated lime, the remaining paris green congregated in islands or groups of particles. This was noted particularly in test No. 7, where 100 per cent mortality was obtained in the pans with only 55 per cent mortality in the breeding area. In test No. 19 hydrated lime was used with practically 100 per cent mortality in both the pans and breeding area. In this area the paris green particles appeared to rest where they had been uniformly deposited on the surface. The water was agitated purposely to break the film, but it promptly closed again, leaving in the end an unbroken film of paris green of apparently equal distribution.

The test showed that there is quite a difference in the bahavior of paris green particles applied to various water surfaces. In some instances the particles sank rapidly with only a small per cent of the larvae obtaining a lethal dose. In other instances the particles collected in groups with incomplete larvae mortality re-

sulting, while in the most successful tests the paris green particles appeared to remain afloat and uniformly distributed. The latter condition is evidently ideal for complete larvae destruction.

The paris green being used on Lake Martin compared favorably with the products from three other manufacturers. No material difference was observed in the comparative tests using a readily sinkable diluent dust and one that floats. A Root hand gun with high speed fan blower was used for dust distribution in the tests, a tabulation of which is given as follows:

During the work, so far as is known, no harmful effects of importance resulted to man, animal or fish. In addition to the ordinary precautions taken, the workers were supplied with simple respirators,[14] which were used only when they were in the dust cloud.

Number of Experiment	LOCATION AND CHARACTER OF BREEDING AREA	Brand Paris Green	Pounds Per Acre Paris Green	Time of Application	Carrier or Diluent	Paris Green Pct. In Mixture by Weight	Accompanying Pan Test	Check Before Application		Check After Application			Pct. Mortality +	
								Number Dips	Total Larvae	Hours Elapsing	Number Dips	Live Larvae Taken	In Pans	In Breeding Area
1	Lake Martin, Brush, Weeds	A	1	9 A.M.	Soapstone	1	none	60	72	6	60	2	.....	97
2	Lake Martin, Brush Weeds	B	1	10 A.M.	Soapstone	1×	none	60	30	6	60	1	.....	97
3	Lake Martin, Brush, Weeds	A	1	10 A.M.	Soapstone	1	none	50	100	5	50	47	.....	53
4	Ditch, dead vegetation	B	1	3 P.M.	Soapstone	1	none	10	44	20	10	8	.....	86
5	Ditch, dead vegetation	A	1	3 P.M.	Soapstone	1	none	10	59	24	10	7	.....	88
6	Ditch, dead vegetation	B	1	4 P.M.	Kaolin Dust	1×	none	10	88	24	10	17	.....	81
7	Ditch, dead vegetation	B	1	4 P.M.	Kaolin Dust	1	yes	10	22	24	10	10	100	55
8	Ditch, dead vegetation	A	1	5 P.M.	Kaolin Dust	1	none	10	50	24	10	9	.....	82
9	Ditch, dead vegetation	A	1	3 P.M.	Soapstone	5	none	10	43	24	10	13	95	70
10	Ditch, dead vegetation	A*	1	2 P.M.	Soapstone	5	yes	30	206	24	30	268	65	Increase
11	Ditch, dead vegetation	A	2	3 P.M.	Soapstone	5	yes	30	176	24	30	112	96	36
12	Ditch, dead vegetation	C	1	3 P.M.	Soapstone	5	yes	30	245	24	30	221	100	10
13	Ditch, dead vegetation	C	1	7 A.M.	Soapstone	5	none	30	444	24	30	267	.....	40
14	Ditch, dead vegetation	D	1	8 A.M.	Soapstone	5	yes	30	321	24	30	206	100	36
15	Ditch, dead vegetation	C	1	9 A.M.	Soapstone	5	none	30	726	24	30	379	.....	48
16	Ditch, dead vegetation	A	3	12 A.M.	Soapstone	50	none	30	268	6	30	125	.....	53
17	Small Pond, logs, grass	C	1	4 P.M.	Hyd. Lime	15	yes	30	104	6	30	0	100	100
18	Small Pond, weeds Algae	C	1	4 P.M.	Soapstone	15	yes	30	93	6	30	2	100	98
19	Small Pond, dead leaves	C	1	10 A.M.	Hyd. Lime	15	yes	10	62	6	10	1	100	98
20	Small Pond, heavy Algae	C	1	10 A.M.	Soapstone	5	yes	10	78	6	10	0	100	100
21	Small Pond, heavy Algae	A	1	11 A.M.	Hyd. Lime	15	yes	27	6	10	0	0	100	100
22	Small Pond, heavy Algae	A	1	11 A.M.	Soapstone	5	yes	10	69	6	10	2	100	97

* Paris Green graded to pass 330-mesh screen and be retained on 200-mesh screen.
\+ Small first stage larvae not counted.
× Copper Arsenate.

(3) There developed certain areas in Lake Martin in 1927 where oil failed to control breeding.

(4) Following the agreement to use paris green in 1928, decision was made to apply the dust through use of a power duster mounted on a boat. The machine was to be supplemented by knapsack hand dusters. Powdered soapstone was selected as a diluent after considering hydrated lime, kaolin and road dust.

(5) After preliminary trial a 5 per cent mixture of paris green was found more suitable for general application than a 1 per cent mixture.

(6) Inspection following the applications of paris green showed that larvae mortality was not uniform in all places.

(7) A series of tests and observations was made in an attempt to ascertain the reason for non-uniform results with the following findings:

(a) The paris green being used on Lake Martin was satisfactory as to chemical content of arsenious oxide.

(b) The fineness of the paris green appeared satisfactory. It was found, however, that paris green retained on a 200-mesh sieve was entirely too coarse for larvicidal work. From our observations it is thought that a more limiting specification on paris green as to coarseness would be that it pass almost entirely through a 300-mesh sieve. No information was obtained

SUMMARY AND CONCLUSIONS

(1) With few exceptions petroleum products have had successful application for control of anopheline larvae on impounded waters in Alabama which were impounded according to the State regulations.

(2) The efficiency of oiling equipment has been rapidly developed since the first major oiling operations were undertaken on Lake Mitchell in 1923.

which might indicate a limiting size as to fineness.

(c) Of the diluents used in the tests (kaolin, soapstone, hydrated lime) no one was observed to be distinctly superior to the others considering larvae mortality alone.

(d) Due to varying influences, as wave action, wind currents and water tension at the surface, paris green is not equally effective on all breeding areas.

(e) As the aquatic growth, flotage and scum increase in density in an area the possible effective use of paris green also increases with a decrease in the possible effectiveness of use of petroleum as a larvicide.

(f) The effective and economic use of paris green as an anopheline larvicide on large reservoirs in Alabama impounded strictly under the regulations is limited to those areas which cannot be successfully handled with oil.

As has been pointed out heretofore by other investigators, it is being suggested to future users of paris green that each lot received be analyzed to ascertain that it contains the minimum of 50 per cent arsenious oxide. In addition, it should be given the pan tests on larvae for toxicity. Complete mortality should result in about two hours. However, one of the most important tests to be made in obtaining a true index of what may be expected is to apply the paris green to an experimental area entirely similar to the larger area to be controlled in the same percentages, the same amount per acre, and using the same diluent.

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MALARIA CONTROL ACTIVITIES IN ARKANSAS, 1927-1928*

By M. Z. BAIR,
Little Rock, Ark.

Compared with the years 1926 and 1927, Arkansas experienced an increase in the amount of malaria during the past year. This statement is based on a 10 per cent increase in the number of deaths reported, and on the advice of physicians generally.

Following the floods of 1927, with the assistance of the United States Public Health Service and the American Red Cross, intensive control measures were conducted in the rural areas affected. As a result of this work, there was no increase in reported malaria. It is very probable that failure to continue this work as intensively as in 1927 resulted in the increase during the past year.

The Field Director of Malaria Control has supervised activities in thirty-one communities by making regular visits throughout the season. Advice and assistance was also given to the officials of nine other communities. The Director also assisted the full-time county health units in inaugurating rural work, and it is hoped that these units will be able to devote more time to malaria, as it is realized that in Arkansas malaria is largely a rural problem.

Arkansas has been greatly aided by the work being done by the railroads. The St. Louis-Southwestern (Cotton Belt), Missouri Pacific and Chicago, Rock Island and Pacific systems have expanded their activities in the State, and through mosquito prevention and quinin prophylaxis are greatly reducing malaria among employes and the citizens of towns on their lines. The educational and publicity measures employed by the railroads are most effective in helping to bring about a widespread desire for the elimination of this disease. Their activities are a real contribution to public welfare and exemplify a fine spirit of public service.

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*Report to National Malaria Committee (Conference on Malaria), meeting conjointly with Southern Medical Association, Twenty-Second Annual Meeting, Asheville, North Carolina, November 12-15, 1928.

MALARIA IN FLORIDA, 1928*

By E. L. FILBY,
Jacksonville, Fla.

This year witnessed a period of heavy rains and high water throughout the State for almost the entire Anopheles season. As a result, we have a marked increase in malaria in our malaria section, which lies west of the Suwannee River and east of Holmes Creek, a branch of the Choctawkatchee River. Failure of physicians to report these cases has had a pernicious effect. as control measures could not be instituted in time. Industry has been brought face to face once more with the fact that malaria is not an aid to good business. The start of an entomological study of the fresh water mosquitoes of Florida has been made by the United States Bureau of Agriculture, Bureau of Entomology, in cooperation with the State Board of Health. The control of brackish water mosquitoes has been urged and a general bill will be introduced at the 1929 Legislature allowing boards of county commissioners to levy a millage for mosquito control work. Interest in this work has been kept alive by the usual methods. There has been practically no interest displayed by the communities in our malaria section. Three coastal counties are doing salt marsh work at this time.

MALARIA CONTROL IN GEORGIA FOR THE YEAR 1928*

By T. F. ABERCROMBIE, M.D.,†
Atlanta, Ga.

The work of malaria control in Georgia for the year 1928 comprised chiefly the making of malaria surveys, together with recommendations for cities, towns and communities, and of assistance rendered county health officers, investigations of epidemics and institution of control measures.

Control of hydro-electric impounded areas required practically the whole time of one engineer. There are now in the State of Georgia over 100,000 acres of impounded areas for hydro-electric purposes, which acreage is divided between about thirty-six hydro-electric plants. Impounding of more acreage is contemplated during the year 1929. All of the impounded areas are either cleared or are in the process of clearing. At least three of these areas are under continuous oil control. The cooperation now being received by the State Board of Health from the various power companies is very gratifying, and it may be stated that the time has arrived when power companies value the control of impounded areas not only as an important health measure, but as a legal protection to the power companies.

Sectional meetings have been held with county health officers in an effort further to promote rural malaria control in the State. Wholesale quinin distribution, drainage and screening is anticipated for the coming year in order that the rural people may be better protected against malaria. Malaria education is also being introduced into the schools through general public health education.

The year 1928 has been an unusual year in amount of rainfall and the result has been an increase in malaria infection. Due to this fact, we anticipate also a high malaria rate for the year 1929, and every precaution is now being taken to keep the rate down to a minimum.

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†State Health Commissioner.

MALARIA WORK IN KENTUCKY, 1928*

By A. T. MCCORMACK, M.D.,
Louisville, Ky.

While malaria is one of our minor problems, it has been increasing the last two years since the flood. In the county in which we had the most malaria, we happened to have $500.00.

We are going to have an enormous increase in malaria unless some steps not yet formulated are taken. A large number of laborers are going to be deposited in the malaria section, a larger number than have ever been similarly imported. The danger to the public health from this population's being suddenly dropped into this section is going to be tremendous. The roads will have to be rebuilt and re-located. An enormous expenditure will be called for, and the counties will not be able to handle it alone. It seems very important that our Congressmen from the South understand the tremendous prob-

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lem that will confront us as these hundreds of thousands of laborers are transported suddenly into the malarial sections.

MALARIA WORK IN LOUISIANA, 1928*

By Oscar Dowling, M.D.,
New Orleans, La.

The campaign has been carried on in Louisiana on the same basis as prior to this, and I am sorry to report have had a slight increase in the number of cases of malaria since the flood. We endeavored to supply quinin for those who wanted it, and the largest amount of quinin went where there had been no official reports of malaria.

In Shreveport we had last year a demonstration of screen making at the Fair and we screened a large number of homes on the farms at a nominal price. One man had four houses on his place and I think there were sixteen doors and fifty windows to those four houses, and they were screened for him at a cost of less than $20.00. Some of the farmers of the State have screened the majority of the homes, and the prospects are that practically all of the homes will be screened.

We have had a few deaths from malaria, but we have nothing to show that there has been any increase. One sanitary engineer devotes his entire time to this work and he helps them to get it started and comes back later. Of the 64 parishes, 31 have full-time men.

MALARIA CONTROL OPERATIONS IN THE STATE OF MISSISSIPPI DURING 1928*

By Felix J. Underwood, M.D.,
Jackson, Miss.

The major malaria problem in the State of Mississippi is confined to the fourteen Delta counties in which reside approximately 25 per cent of the State's population, and among whom about 50 per cent of the State's reported malaria cases occur each year.

In this territory there are eleven full-time health units, and in the State there are twenty-six such units.

The policy of the State Board of Health is to include malaria control operations in the regular county program of full-time units in those counties having malaria problems.

Aid is rendered from the central organization through the Division of Malaria Control to all sections of the State.

In Humphreys and Leflore Counties, as part of the program of the full-time health departments, malaria control work was given serious consideration and a great deal of work done during the year.

Coahoma, Bolivar and Sunflower Counties were grouped into a general malaria control unit, aid from the central office being rendered in working out practical programs for the three full-time health departments concerned.

Control operations, began in 1922, were continued by the full-time health unit in Yazoo County.

In Hinds County, and particularly the City of Jackson, malaria control work was firmly established during 1928 as part of the county health department's program.

While all full-time health units have done some malaria control work, the above lists the outstanding projects.

Thirteen municipalities, with an aggregate population of 169,000, carried on general mosquito control programs during the year, and insofar as anopheline mosquitoes were controlled the transmission of malarial fever was affected.

The desire of the urban population is for general mosquito control, and many towns throughout the State annually conduct such programs of their own initiative.

Plantation owners having had various malaria control measures explained as being suitable for practical use on their plantations, have taken up the work, and in a number of such cases minor drainage projects have been mapped out for them, to be handled after the cotton crop is disposed of. Such work makes available additional acreage for cultivation and reduces mate-

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rially the local production of Anopheles mosquitoes.

Of outstanding importance are malaria control operations which have just been started on a plantation group of 35,000 acres.

Some 24,000 acres of this plantation group were in cultivation this year, supporting 761 houses occupied by 2,623 colored persons. The immediate plan of the owners is to increase the number of families to 1,000, which will give a population of 4,000 to 4,500.

The malaria problem has been gauged by collecting histories by a house-to-house canvass on the fifteen units into which the plantation is divided. There were obtained 1,081 colored histories for 1928, or a rate of 41.2 per cent. The data relating to the white population, occupying 42 houses located largely in the town, have not at this time been compiled.

Of 1,598 blood films collected from colored tenants, the examining to date of 769 gives a positive blood rate of 16.6 per cent.

Each unit of work was separately conducted, and each unit of area was separately dealt with, histories for 1927 and 1928, age, sex, color, length of residence, type of dwelling, anopheline density, anopheline production, methods of practical application of control measures, a 61 per cent blood index, were included for the malaria study.

General information pertaining to excreta disposal, water supply, number of cows and milk consumption, garden and kind of vegetables raised, tuberculosis suspects, and pellagra cases noted, in connection with the malaria work was recorded at the cost of little or no additional time.

All persons whose blood was found to contain malarial parasites were immediately placed under treatment of the plantation physician.

A program of control embracing all of the known effective and practical measures, to be applied where they fit, has been mapped out.

A sanitation program including the installation of sanitary excreta disposal units was placed in operation immediately following the survey.

This survey took about twenty-one working days and was worked out and supervised by the Division of Malaria Control of the central organization.

Similar sectional surveys are being extended into other counties, and in these areas drainage of both a large and small nature is being gotten under way.

Cooperation with dynamite agencies, plantation owners, drainage commissioners and city officials has opened the way for some extensive drainage this winter when vegetation is less dense, the soil more suitable, and labor more plentiful.

While the general trend of malarial fever in Mississippi is downward, this year as well as 1927 has shown an increase over the preceding year.

As part of the activities of the year cooperation was rendered in connection with working out of a program for the control of the salt marsh mosquitoes in the three Mississippi Gulf Coast counties. This cooperation included aid in preparing and securing the passage of a bill by the 1928 Legislature entitled "An Act Enabling the Establishment of County Mosquito Control Commissions and to Define Their Powers and Duties, and for Other Purposes" (H. B. 1157).

This Act was passed, and on April 23, 1928, was signed by the Governor.

The original bill extended its provisions to all eighty-two counties, but an amendment was added limiting its effectiveness only to those counties bordering on tide water and on the Mississippi River.

No distinction is made regarding the class of mosquitoes so it may also, as was the aim, serve by enabling certain counties to assess themselves for the control of malaria-transmitting mosquitoes.

Harrison County appropriated $20,000 under this Act, Hancock County appointed commissioners, and both Hancock and Jackson Counties plan to make substantial appropriations in 1929 to insure a general and cooperative control program in the three coastal counties in Mississippi.

It is hoped that Louisiana and Alabama will enact similar legislation to enable Mississippi to extend cooperation to its neighboring states.

MALARIA WORK IN MISSOURI, 1928*

By W. S. PETTY, M.D.,
Caruthersville, Mo.

I happened to be in the southeastern part of Missouri, where malaria is a problem. Particularly in seven counties it is a serious problem.

We have been doing some screening and Mr. LePrince and Mr. Johnson have been helping us considerably in that area.

Last year at our State Conference the health officers, the seven full-time men, took up most of the time with malaria. The other men rather resented the fact, but just this year near Kansas City and the central part of the State there are some impounded projects, some power sites and some pleasure resorts, and I was informed the other day they were beginning to receive quite a number of blood smears from that section.

Doctor Stewart, State Health Commissioner, is very keenly interested in malaria control measures. This year, or the next Legislature, which convenes in January, they hope to have some legislation regarding the impounding of waters in the State of Missouri.

MALARIA ACTIVITIES IN NORTH CAROLINA*

By CHAS. O'H. LAUGHINGHOUSE, M.D.,
Raleigh, N. C.

An ever-increasing demand on the State Board of Health by county officials, property owners and others interested in public health work for a more comprehensive plan for dealing with the malaria problem of the State led the members of the Board during 1921 to consider a means for accomplishing rural control with the idea in mind that any findings obtained during the initial work might be made a part of the routine of the health department of the State.

As the mortality records furnished the only available data relating to the prevalence of malaria, and as this was found to be inadequate as a basis for formulating a control program, it was decided to undertake intensive surveys in some of our eastern counties in order to determine: first, the incidence of the disease and the extent to which it is a menace to the health and economic efficiency of the people; second, the possibility of controlling the disease at a cost within the economic reach of the average county.

A study of the data collected during these surveys and of the morbidity statistics of the State indicates that malaria is of serious public health importance only in that group of counties about two in width bordering along the Atlantic Coast, with a higher incidence in those counties affected by tide water through their small streams leading to Pamlico Sound and the Atlantic Ocean (see *Map*).

A more careful study of the available records for that group of counties bordering the coast would lead one to believe that the mortality from malaria, although subject to annual fluctuation, is decidedly on the decline. This decline in the death rate is perhaps due largely to the less severe types of the disease rather than to a true decline in the incidence. All along the eastern coast of the State, where malaria is to be found in abundance, and where it is a menace to the health of the people, one will find an even climate, not too cold, for more than four months of the year, to prevent sporadic mosquito flights, and a water table nowhere lower than a few feet below the surface. The elevation of each county is only a few feet above sea level and a majority of counties feel regularly the effects of tidal waters. The soils range from the light deep sandy soils of the interior to the deep black pasty swamp lands near the coast. The low, swampy condition of almost the entire eastern section of the State and tidal waters covering the low lands at regular intervals offers excellent opportunities for the propagation of malaria-carrying mosquitoes, and it is in these regions that the State Board of Health is attempting to concentrate its efforts in the control of the disease.

Since the inception of the work in 1921, which was in cooperation with the International Health Board of the Rockefeller Foundation, the organization of the State Board of Health has embraced a Division of Malaria and Mosquito Control through which aid, both advisory and supervisory, is rendered throughout the State on problems pertaining to the investigation and control of malaria and mosquitoes. The division thus created seeks to organize local county health departments whose duty it is to carry on investigations and control measures wherever

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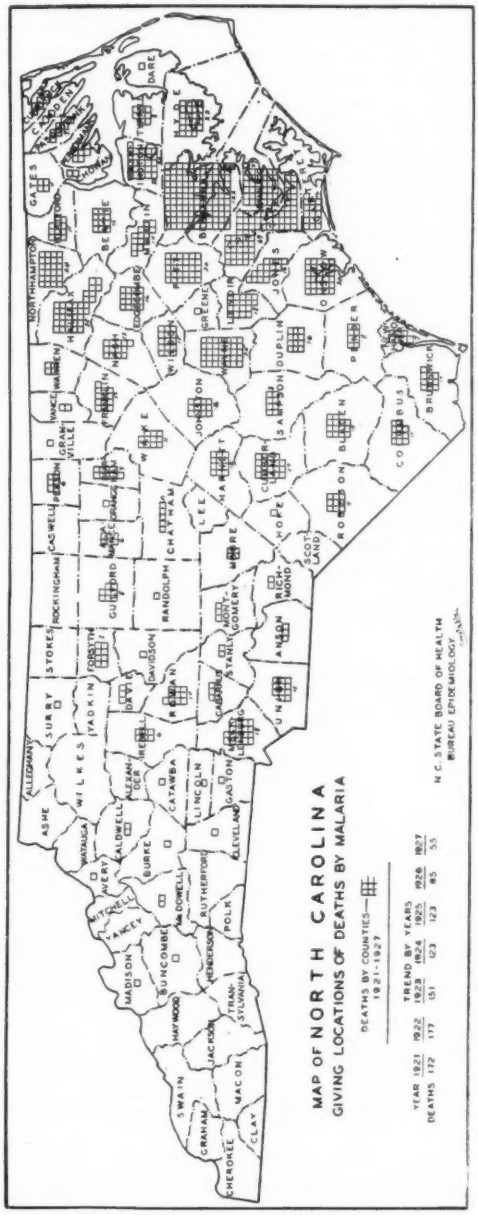
the disease is prevalent enough to justify the effort and expenditure of money. While the primary object of the division created is necessarily the mapping out of the malaria problem in all the counties within the malaria zone and instructing employes of local county health units in measures for the control of the disease, there is a secondary object of even greater importance, which is the stimulation of permanent interest and activity in public health work in general and the local administration of methods whereby disease prevention can be carried on economically and on a large scale by free and generous support of full-time local health departments.


MAP OF NORTH CAROLINA
GIVING LOCATIONS OF DEATHS BY MALARIA
DEATHS BY COUNTIES—
1921-1927
TREND BY YEARS
YEAR 1921 1922 1924 1925 1926 1927
DEATHS 172 177 151 123 85 55
N.C. STATE BOARD OF HEALTH
BUREAU EPIDEMIOLOGY

In addition to rendering aid and advice to county health departments in the control of rural malaria, the Division has been engaged in studying (a) what, if any, influence the impounding of waters may have upon the incidence of malaria; (b) malaria and mosquito surveys in urban areas; and (c) salt marsh mosquito problems.

STUDIES ON IMPOUNDED WATERS

The studies on impounded waters were conducted with a dual purpose: first, to safeguard communities from the hazards and accidents to health that have proved to be the companions of oversight, imprecaution, or lack of knowledge in the construction of ponds; second, to set forth facts and knowledge surrounding the impounding of water in order that power developers and other interests might utilize them in clearing the flanks of a basic industry and lead other industries to whom they furnished power to recognize and aid public health projects.

To serve these purposes, two courses were followed. Prior to impounding, sites were surveyed over extended periods of time to ascertain and record something of the prevalence of malaria and malaria-carrying mosquitoes (*Anopheles quadrimaculatus*). Records of past conditions, tendencies and possibilities were thus compiled and rendered available to all concerned.

Following impounding, periodic inspections of ponds were made. Written and photographic reports of findings were rendered, thus putting in the hands of those concerned definite data on developments and tendencies. In this manner it was hoped to avoid the pitfalls of oversight and to aid in reducing the friction of change and readjustment.

SURVEYS OF URBAN AREAS

Surveys of urban areas have been conducted with two aims: (a) to control disease, and (b) to eliminate pests. In disease transmission *Anopheles quadrimaculatus* and malaria were the chief concerns. However, possibilities are not limited here; for *Aedes aegypti* or Stegomyia,

the carriers of dengue and yellow fever, have been observed in large numbers throughout the coastal section of the State and as far inland as Raleigh. Pestiferous mosquitoes are usually the result of poor sewage disposal and generally unclean conditions which are at times permitted to develop. *Culex quinquefasciatus* and probably at times *salinarius* are the concern here.

SALT MARSH SURVEYS

Salt marsh mosquitoes, *Aedes sollicitans* and *Aedes taeniorhynchus*, have attracted an increasing amount of attention, probably due in some measure to increasingly favorable conditions for their production, but primarily due to their standing in the way of agricultural and industrial progress. As an answer to the demand for attention to this problem, the State cooperated with the United States Public Health Service in conducting salt marsh surveys.

MALARIA REPORT FOR SOUTH CAROLINA, 1928*

By R. G. HAMILTON, M.D.,
Columbia, S. C.

During the first part of the year the malaria case rate ran about on a par with former years. During the latter part of the summer three severe storms each caused an overflow along the river valleys in the lower part of South Carolina, which produced enormous quantities of quads breeding in cotton patches and corn fields, causing an epidemic in Clarendon, Marion and Colleton Counties.

Immediate steps were taken for the control of these epidemics and good results were obtained by the use of quinin. This quinin was provided by the American Red Cross. Marion County provided $2,000 for the purchase of quinin and other necessary drugs for those affected with malaria in the lower part of the County.

The Malarial Department has visited practically all of the towns and cities in the State, getting cooperation from the city and county health officers in the control of breeding in their respective towns.

The impounded waters of the State have been inspected at various times during the year and practically no breeding was occurring on any of these projects. A continuous study was made during the summer of the Lake Murray area. Control measures have consisted in the screening of houses, oiling, dusting and ditching.

The State Highway Department has cooperated in a wonderful manner by opening drainage ditches on their rights of way, and, where this was impracticable, installing oil drips or using oil sprays.

In the town of Bamberg the drainage system was practically wrecked by the falling of trees into the ditches and the caving of the banks.

The funds for the malaria work in South Carolina are contributed by the International Health Board and the State. Doctor Ferrell kindly lent the State Dr. L. T. Coggeshall for work on the Saluda Dam project.

During the year Mr. LePrince, of the United States Public Health Service, has continued his series of lectures to the engineering students of the three State colleges. These men are future engineers for the State Highway Department and other projects where knowledge of malaria prevention will be of value. Mr. Legare, the Chief Engineer of the State Board of Health, has cooperated in every way possible.

During the year Dr. L. L. Williams, of the United States Public Health Service, has visited us several times, rendering valuable assistance in suggesting certain control measures in various sections of the State.

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PROGRESS REPORT OF MALARIA CONTROL IN TENNESSEE IN 1928*

By E. L. BISHOP, M.D.,
Nashville, Tenn.

Both extensive and intensive study and definition of our malaria problem in the western section of Tennessee are being carried out from Lake County as a field base. With one exception every county in the tier bordering the Mississippi River now has a full-time county health department and both study and control activities are, therefore, more surely productive of results.

Twenty-two cities and towns did mosquito control work this year. They are Memphis, Covington, Ripley, Halls, Dyersburg, Union City, Franklin, Tiptonville, Ridgely, Martin,

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Trenton, Humboldt, Milan, Cookeville, Brownsville, Dresden, Jackson, Cowan, Murfreesboro, Chattanooga, and Greenfield.

Memphis was the largest city doing anti-mosquito work. Thousands of gallons of waste oil from filling stations were used and bayous and ditches throughout the city were trimmed free of grass and weeds and oiled regularly. Memphis was without the service of a full-time sanitary engineer this year and a sanitary engineer from the State Health Department was detailed to give consultant service throughout the season.

Activities in other cities and towns consisted mainly of oiling, clearing, and ditching of streams. Preliminary surveys, estimates of cost where needed, and inspection trips during the mosquito breeding season were included in the services of the State Department of Health.

Tennessee had two impounded water problems during the year. The Tennessee Electric Power Company did paris green dusting over one of its large backwaters that could not be otherwise satisfactorily controlled at this time. The City of Cookeville carried on control work at the Falling Water River reservoir. A partial break in this dam which lowered the water level about six feet materially improved the shore line for mosquito control, as it left no vegetation whatever in the water. The dam is being rebuilt and raised. In Lauderdale County fifty-four homes on a single large plantation were screened for study and demonstration purposes. Paris green dusting was also done on this plantation to control *quadrimaculatus* breeding over one small and one very large marshy area near the homes.

In Lake County a county-wide screening program was inaugurated early in the year. Lake County has the highest malaria rate of any county in the State. It borders the Mississippi River on the west and Reelfoot Lake on the east, and is traversed by several bayous. Mosquito proofing is being done this winter.

A total of 2,152 doors were made this year for 880 homes in Lake County. Last year 165 homes were screened, making a total of 1,405 homes in Lake County screened to date, or 59.7 per cent. This does not include a large number of homes that were screened as a result of the campaign by the owners themselves.

MALARIA CONTROL IN VIRGINIA*

By H. G. GRANT, M.D.,
Richmond, Va.

In thirty-one unorganized counties educational work has been carried out through the schools; pamphlets giving the theory of malaria transmission and dealing with practical methods of control have been distributed to the homes. In our organized counties education and control has been carried out where deemed necessary.

In the ten organized counties in Tidewater, Virginia, with a total population of, roughly, one quarter of a million, there were four deaths from malaria reported in 1927, and up until the time of writing, no deaths in 1928. The number of cases reported from this group of counties has been exceptionally low; in 1927 only 188 cases were reported, and up until the time of writing in 1928, 126 cases. It is probably true that the number of cases reported is far too low, and if anything the number of deaths is too high.

In Northampton County, in Cumberland County and in Southampton County control has been effected by the use of paris green dust. In Nansemond County and in Isle of Wight County control has been carried out by fluctuation of water level, by drainage and by screening. Drainage and regular oiling has been carried out in Greensville County. Pest control has been effected by drainage and the use of oil at Virginia Beach in Princess Anne County, Tappahannock, Suffolk and in Orange County.

A check-up on our reporting system by the thick film method of blood examination is at present being conducted in cooperation with the United States Public Health Service. School children are being examined in parts of the State where we know malaria had previously been prevalent. It is expected that we shall make about 10,000 examinations and in this way get an accurate estimate of the present status of malaria.

*Report to National Malaria Committee (Conference on Malaria), meeting conjointly with Southern Medical Association, Twenty-Second Annual Meeting, Asheville, North Carolina, November 12-15, 1928.

Southern Medical Journal
JOURNAL OF THE
SOUTHERN MEDICAL ASSOCIATION

Published monthly by the Southern Medical Association, Empire Building, Birmingham, Ala. Annual subscription $4.00. Single copies 35c each.

Entered as second-class matter at the Post Office at Birmingham, Ala., under Act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in Section 1106, Act of October 3, 1917, authorized December 20, 1921.

DR. M. Y. DABNEY, Editor
C. P. LORANZ, Secretary-Manager

Vol. XXII APRIL 1929 No. 4

EDITORIAL DEPARTMENT

SOUTHERN MEDICAL ASSOCIATION
Twenty-Third Annual Meeting
Miami, Florida, November 20-22, 1929
Pre-Meeting Clinics, November 19, 1929

EFFECTS OF ARTIFICIAL RIPENING AND BLEACHING OF VEGETABLES AND FRUITS

Ethylene has been used commercially to some extent for the last three years for hastening the ripening of fruits and vegetables, the public taste for fresh vegetables out of season being largely responsible. The process certainly has an artificial sound, and one would feel that some traces of the effect of ethylene ripening would be apparent in the food value of the fruits themselves.

Ethylene, a highly combustible gas, was first considered as an anesthetic for human beings because of its effect in closing carnations.[1] In the very small quantities used by fruit growers it causes an increase in the respiratory rate and "acts as a stimulus to the normal oxidative processes in the fruit." It can act as a catalyzer, converting pure dry starch to reducing sugars in the absence of the enzyme amylase. The conversion is obtained also if a starch solution is saturated with ethylene and allowed to stand.[2] It is of course known that in the natural ripening of fruits, stored starch is converted to sugar.

1. Editorial, Physiologic Effects of Ethylene. JOURNAL, 21:782, 1928.
2. Rea, H. E., and Mullinix, R. D.: Jour. Amer. Chem. Soc., 49:2116, 1927. Quoted by 3.

Tomatoes for market purposes are commonly subjected to this treatment. Some gratitude is due House, Nelson, and Haber,[3] of the Iowa Agricultural Experiment Station, for investigating the vitamin content of these tomatoes and comparing it with that of tomatoes ripened under other conditions. Four different batches of tomatoes were compared: green tomatoes, tomatoes picked green and ripened in laboratory air; those ripened in the presence of ethylene air; and a fourth group which was allowed to ripen thoroughly on the vine. The tests were made in the usual way, by feeding the tomatoes to small animals on a diet deficient in the vitamin in question, and determining the curative or protective effect.

The four lots of tomatoes were equal in vitamin B content. The A content was greater in ripe than in green tomatoes, no matter how the ripening was secured. Vitamin C was found to be almost entirely absent from green tomatoes. The air ripened and ethylene ripened contained approximately equal amounts; but those ripened on the vine were very much superior in vitamin C.

It was concluded that the commercial method of ripening tomatoes in an ethylene air mixture produces a fruit as rich in vitamins A, B and C as is the fruit picked green and allowed to ripen in the air. The best fruit is that which ripens on the vine.

Another artificial custom or method of tampering with natural products which is common under present day market conditions, is that of bleaching lettuce, celery and asparagus, because the bleached vegetables have a readier sale than the green. It has been rather definitely shown that the vitamin A of lettuce is associated with its green leaves and is almost entirely absent from the white portions. Vitamin A tends in general to occur with the green parts of plant tissue. Crest and Dye,[4] of Michigan State College, have made studies of the vitamin A of green, bleached, and canned asparagus. Green asparagus, even if canned, was found to be a good source of vitamin A, but large quantities of bleached asparagus failed to protect

3. House, M. C., Nelson, P. M., and Haber, E. S.: Vitamin A, B and C Content of Artificially versus Naturally Ripened Tomatoes. Jour. Biol. Chem., 81: 495, Mar. 1929.
4. Crest, J. W., and Dye, M.: Association of Vitamin A with Greenness in Plant Tissue. Vitamin A Content of Asparagus. Jour. Biol. Chem., 81:525, Mar. 1929.

rats on an A-deficient diet. Green asparagus, either fresh raw, fresh cooked, or canned, 0.1 gram per day per animal, contained enough vitamin A to promote growth and health.

It was observed that in the etiolated parts of asparagus there is a large accumulation of the protein building stones, amino and amido compounds, which were not promptly synthetized into the plant proteins. In high concentration these intermediate compounds are unfavorable to animal metabolism. The vitamin A poverty was thus perhaps not the only objectionable feature of the bleached asparagus. The green asparagus had less water and iron than the bleached, but was richer in ash. It had more nitrogen, sulfur, calcium, phosphorus, and possibly manganese, than the bleached.

From the asparagus and tomato experiments, then, one may conclude that the plant is best suited for food if it is ripened on the vine, and if it is allowed to green naturally. It is sometimes difficult to procure vegetables of this high nutritive value in the market.

The physician, particularly the pediatrician, may find it advisable to prescribe for his patients a home garden, where lettuce may be greened and tomatoes ripened on the vine. This would not actually be beyond the reach of the average individual in the still uncrowded South. But more simply, public demand will eventually change the market supply.

MALARIA IN THE LAST TWO YEARS

The summer of 1926 saw the end of a steady and long-continued decrease in the malaria rate in the Southern states. The next season revealed a moderate increase, which became marked in 1928. The increasing rate has been accompanied by a more severe form of malaria than has been seen for a number of years. Some black water fever has appeared in a few sections, much hematuric fever in others, and the death rate from this disease has become alarming in some states.

In ten of the twelve most malarious states, a definite increase has been recorded from 1926 through 1928, worse in 1928. In these ten states, the rise has been moderate in five and severe in the other five. In Georgia, the death rate for malaria in 1928 increased to 80 per cent more than the rate in 1927.[5]

5. Williams, L. L., Medical Officer in Charge, F. I. Malaria, U.S.P.H.S.: Personal communication.

Acute epidemics have been investigated in South Carolina, Georgia, and Florida. Black water fever has been seen in two of these states and hematuric and cerebral forms in four states. Blood indices have shown infection rates of 30, 40 and over 50 per cent in certain areas of three states.[5]

The problem of malaria is now but slightly urban; it is almost wholly rural, since most of the cities and towns have obtained mosquito control by means of drainage and larvicides, measures formerly of too great cost for extensive rural application. The farm tenant has always been the chief sufferer from the disease, and the recent rise of malaria with its increased severity has in many areas placed on him a well-nigh insuperable burden. Except in the recently inundated areas no concerted effort has been made to control this easily controllable disease on a county-wide scale. The farmer produces the raw materials for the Country, and upon him as upon an inverted pyramid rests the prosperity of the Nation. Where his health is poor and consequently production low, there is no inducement for the development of new enterprise.

Control of malaria is the first step toward farm relief in the South, and control is not only possible but is simple, since recent developments have brought relief from malaria within economic reach of the rural inhabitant. It has been demonstrated that there is no such thing as an unscreenable house. Any shack can be mosquito-proofed for less than $10.00. A county malaria control commission can, with a revolving fund of $1,000.00, screen an entire county. Cheaper methods of paris green application permit any health department or control commission to dust all or nearly all breeding areas in an average county, within a cost that is reasonable. An educational campaign to induce sufferers to use quinin adequately would greatly lessen the amount of malaria and is an invaluable adjunct to any method of control.

Industry looks towards the South and Southwest for new and better locations, but industries demand a healthful environment and are repelled by a high malaria rate. State health departments have received many inquiries concerning malaria conditions at proposed sites for new factories. In at least one case a site was rejected because the malaria rate was high and no steps were being taken to reduce it.

No permanent rural control campaign has

been successful without the presence and active direction of a county health department, or at least an active malaria control committee. This has been essential to success. When all rural Southern sections have adequate health service, and when malaria control measures are better known among the farmers, malaria will be exterminated, a condition to be looked forward to in the near future.

LIVER EXTRACTS IN PERNICIOUS ANEMIA

The treatment of pernicious anemia by liver feeding, which seemed at first blush to be a scientific discovery proceeding from most orderly animal investigations, appears, viewed from another angle, to be more nearly a lucky chance from the trial and error school. It upholds again the worth of carefully conducted empirical studies. Science and humanity can benefit greatly by accurate observation of phenomena which they may never be able to explain.

In the evolution of the present treatment of human pernicious anemia, Whipple and Robscheit-Robbins[6] over a number of years made healthy dogs anemic by bleeding, and determined their rate of hemoglobin regeneration on different diets. They observed great variations in the rate, depending upon what the dogs ate, and concluded that the rate of hemoglobin regeneration was almost wholly a function of the feeding. Whole liver was found to have so powerful a stimulating effect on the blood-forming organs of the dogs that they suggested its trial in human anemias. Thus the idea developed of the importance of diet in anemia, and of the requirement of specific organic materials such as liver, rather than an inorganic metal such as iron.

Minot, Fitz, Murphy and Monroe[7] were led by these suggestions to treat human pernicious anemia, a wholly different condition from the dog anemia, by feeding large quantities of beef or calf liver, and, to the surprise of the medical profession, this hitherto incurable disease responded very promptly to the treatment. Cases in severe relapse were rapidly improved by it. Yet liver feeding was usually ineffective in secondary anemias, which more closely resemble the dog anemia which first suggested its trial.[8]

In the last two or three years amplification of these facts has proceeded in several directions. Whipple and Robscheit-Robbins have continued working with the dog technic elaborately developed by them. They have investigated the effects of various other foods, of ashes of liver or fruits, salts and liver extracts upon hemoglobin regeneration of the dog. The ash of liver and of apricots was found stimulating.[9]

In Wisconsin, the effect of certain foods and minerals upon a dietetic anemia of small animals has been studied, and copper salts were noted to be of importance in this condition. The liver extract of the Harvard committee and its ash were also effective.[10]

The purification of the actual substance or substances in liver which bring about the improvement in the blood picture of pernicious anemia can be accomplished only by trying different liver fractions, or portions of liver, on human cases. This phase of the work is limited, therefore, to those who have a large clinical material at hand. By cooperation of the Harvard University laboratories, where the liver could be subjected to careful analysis and fractionation, with the Peter Bent Brigham and Massachusetts General Hospitals, where abundant clinical material was available, considerable purification of the active principle has been obtained.[11] It was necessary to try each fraction prepared upon patients in relapse and observe

6. Whipple, G. H. M., and Robscheit-Robbins, F. S.: Blood Regeneration in Severe Anemia. Amer. Jour. Phys., 72:395, 1925.
Ibid., p. 408, 419, 431. Ibid., 79: pp. 260, 271, 280, Jan., 1927.

7. Minot, G. R., Fitz, R., Murphy, W. P., and Monroe, R. D.: Observations on Patients with Pernicious Anemia Partaking of a Special Diet. J.A.M.A., 86: 1861, 1926.

8. Minot, G. R., and Murphy, W. P.: A Diet Rich in Liver in the Treatment of Pernicious Anemia. J.A.M.A., 89:759, 1927.

9. Robscheit-Robbins, F. S., Elden, C. A., and Whipple, G. H.: Inorganic and Organic Diet Factors in Hemoglobin Regeneration During Simple, Severe, Secondary Anemia in Dogs. Amer. Jour. Phys., 85:402, 1928.

10. Hart, E. B., Steenback, H., Waddell, J., and Elvehem, C. A.: Iron in Nutrition. Jour. Biol. Chem., 77: 792, 1928.
Also, Waddell, J., Steenback, H., Elvehem, C. A., and Hart, E. B.: Iron in Nutrition. Jour. Biol. Chem., 77:769, 1928.

11. Cohn, E. J., Minot, G. R., Allis, G. A., and Salter, W. T.: Nature of the Material in Liver Effective in Pernicious Anemia. Jour. Biol. Chem., 77:325, 1928.

its effect on the blood picture. An active extract was found somewhat quantitatively to stimulate the production of reticulocytes so that they might rise to a very large figure during the first five to ten days of feednig. Thereafter their number decreases and the number of mature erythrocytes steadily rises. The efficacy of an extract could be estimated to some degree in the first ten days of feeding. An extract apparently as potent as the original liver has been obtained, of which 0.6 grams per day produces pronounced response of the reticulocytes of pernicious anemia patients. The most potent extract reported was apparently free from vitamins A, B, C, D or E. It was soluble in water, insoluble in ether, free of iron, protein, carbohydrate and lipoids. It appeared to be either a nitrogenous base or a polypeptide. It was reported by Dr. Florence Sabin to have a stimulating effect on the growth of immature red blood cells of the chick embryo. This is undoubtedly a very significant biological response.

The potent extract of the Harvard workers was found by Sperry, Elden, Robscheit-Robbins and Whipple[12] to be relatively inert for their dogs made anemic by bleeding. These workers also prepared large numbers of liver fractions for testing on their dogs, and it appeared to them that almost any method of fractionation destroyed some of the liver's potency. Practically all fractions and residues contained materials which the anemic dog was able to utilize to form new red blood cells and hemoglobin, quite contrary to the results of the Harvard workers with pernicious anemia. A number of factors both organic and inorganic seemed to them to be concerned in the liver effect in simple experimental anemia due to bleeding.

The physician is happy to have a successful treatment for a grave disease, whatever its explanation. Careful observation of the results of liver feeding in human cases should be practised by all who use the method; for anyone may record facts which can eventually throw important light upon the chemical and biological factors involved.

12. Sperry, W. M., Elden, C. A., Robscheit-Robbins, F. S., and Whipple, G. H.: Blood Regeneration in Severe Anemia: Liver Fractions and Potent Factors. Jour. Biol. Chem., 81:251, Feb., 1929.

Miami---Where We Meet

BIG GAME FISHING*

One of the most exciting sports is big game fishing in the Gulf stream off Miami. There is more continuous thrill in it than in hunting big game animals. You may battle with a leaping fish for hours before you finally tire the powerful agile body enough to capture it.

It is a poor man's as well as a rich man's sport. There are no keep off signs on the ocean. Game fish can be caught from a sail boat, row boat, and many of them even from the shore or the pier.

There are fish weighing from 50 to 5,000 pounds that will carry a line through wild dashes, circles and leaps, covering a circuitous 500 yards to 50 miles before the kill. Some of them are less known than the almost extinct okapi of the Congo jungles. Only those who have seen the real colors of these glistening, shimmering monsters as they are first taken from the water before the nervous reaction of death has changed their colors can appreciate what it means to land one.

The greatest game fish of the semi-tropical ocean are the free swimming fish that seek their prey on or near the surface. They must be fast enough to catch their prey even when the latter are not in schools. They are attracted by the moving bait at a long distance and are much more agile and powerful than reef or bottom fishes.

Some of these free swimmers may come thousands of miles to the spot at which they are caught. A baby sailfish has never been caught in Florida. Science has not yet ascertained its breeding place. The sailfish cruises in the Gulf stream near Miami and is caught all along the southeast coast of Florida.

The average person knows less about the game fish of the semi-tropic seas than about the dinosaur. There are many species of leaping, fighting fish in the Gulf stream and along the Florida reefs and keys. The American Museum of Natural History has hung upon its walls mounted specimens of some of the sportiest water fish found along the Florida coast. In doing so it has paid tribute to a big game resource that seems to be as plentiful one year as the next.

The tarpon is the cleverest big game fish in throwing the hook and runs in size to 215 pounds.

Amberjack is a powerful, heavy-shouldered, hard-mouthed fish weighing up to 100 pounds, often a hard fighter and the most inquisitive of all big game fish. If you can catch one of a school the others will come up to see what is the matter.

King fish is of the mackerel group, almost as speedy as the sailfish; a magnificant fighter and leaper, with a grip like a bulldog when the hook is set in his mouth. They weigh up to 100 pounds, but 40 pounds is a big specimen.

Then there are members of the grouper family. Some of this group run up to 500 pounds. For the most part they are a stodgy, solid fish, but some of the smaller ones, like the Nassau grouper, will sometimes take to the air and put up a thrilling sporty fight.

*By Hamilton M. Wright, Director, Department of Publicity, City of Miami.

There are blue fish, crevalle, Spanish mackerel, bonito, hermit, snappers and scores of others. No one knows what he may catch. Fishermen last spring landed a whale shark weighing five tons after a twenty-four-hour fight.

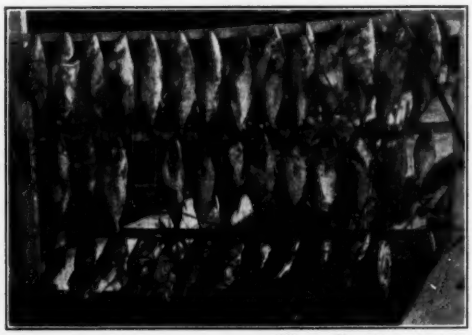
Probably the "smartest" fish of all, if you can call a fish "smart," is the gray snapper.

Dr. Langley, of Goucher College, Baltimore, experimenting at the Carnegie Biological Laboratory on Loggerhead Key, found that gray snappers would learn that an artificially colored minnow was good to eat more quickly than any other fish.

The tarpon is so well known that a description of this superb member of the herring group is unnecessary. He has more ways of ridding himself of the hook than has any other big game fish. He will leap free of the water, distend his gills, and shake his great head from side to side, with huge mouth agape. Sometimes he will throw the hook from his mouth for a distance of 50 feet.

The silver flashing barracuda, most voracious fish in the seas, which sometimes reaches 10 feet in length, makes a splendid game fish when caught on light tackle. Last spring in one day my largest one weighed over 24 pounds. He threw himself fully four feet above the surface when first hooked. The barracuda will often bite in two other fish that are on the line. The barracuda is armed with huge canine teeth an inch long and literally chops large hunks of flesh out of its victim. It will rush at any moving object and can be often lured right up to the stern of a boat by a white rag trailed on a fish line.

The sailfish, swiftest swimming game fish, has a speed of from 60 to 70 miles an hour, can leap over 40 feet of water, "walk the water" for 50 feet or more, and reaches more than eight feet in length. Sportiest of free swimming game fish is this magnificent leaper of the Gulf stream, scientifically described as istiophorus nigricans. He occupies a place in the great group of mackerel-like fishes and, like the sword fish, disables his prey by slashing it with his long, bony beak. No one knows the purpose of the enormous frilled fin upon his back. It is probably to steady him in his lightning swift rushes.

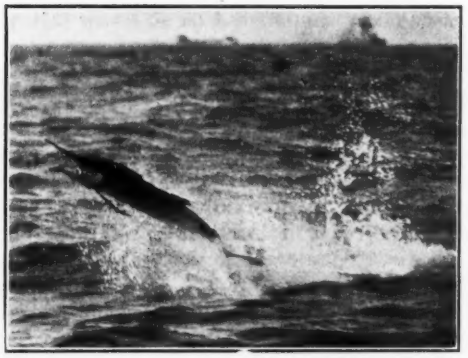


(Photo Hamilton Wright.)

A DAY'S CATCH IN THE GULF STREAM OFF MIAMI

An entire school of dolphin, game, hard fighting small fish, was brought in by one angler during an afternoon in the Gulf stream. The dolphin is considered one of the best fighters of the small fish and a catch of this size can be classed as a good day's work and sport for any angler.

George G. Schutt, of Long Key, an authority, believes him to be the fastest game fish. When hooked he will put up the most thrilling battle in the world. He has been known to hurl his huge eight-foot body clear of the water twenty-seven times. He shakes his head in angered terror as he tries vainly to cast the hook from his mouth, lashing the water into foam. The strangest sight is to behold a hooked sailfish "walk the water," as with body almost erect and only his tail in the water he forces himself over the surface to a distance from 40 to 150 feet. One can imagine the terrific velocity of this long, heavy body charging through the water at better than a mile a minute.



(Photo Hamilton Wright.)

HARD-FIGHTING SAILFISH MAKING A SPECTACULAR LEAP OFF MIAMI

The courageous sailfish, one of the hardest deep sea fighters in tropical waters, is among the spectacular game fish of this section. It can leap and plunge and hurtle its body 30 feet clear of the water after it is hooked. Photo shows the sailfish coming up for its first leap of the flight. The camera was timed perfectly to get this beautiful specimen off Miami in the Gulf stream.

Bone fish is a silver-hued, ebony-eyed fish of the herring tribe, and the sportiest fish of his size. He is shy and hard to hook, as his mouth, tongue and palate are covered with teeth. The record bone fish caught weighed over 14 pounds. He is a white-green ghost with ebony eyes, who will grab a hook and rush like a streak of lightning 500 feet in a straight line in shallows not more than 18 inches deep. The bone fish is the strangest, most elusive fish. The average bone fish weighs from three to seven pounds.

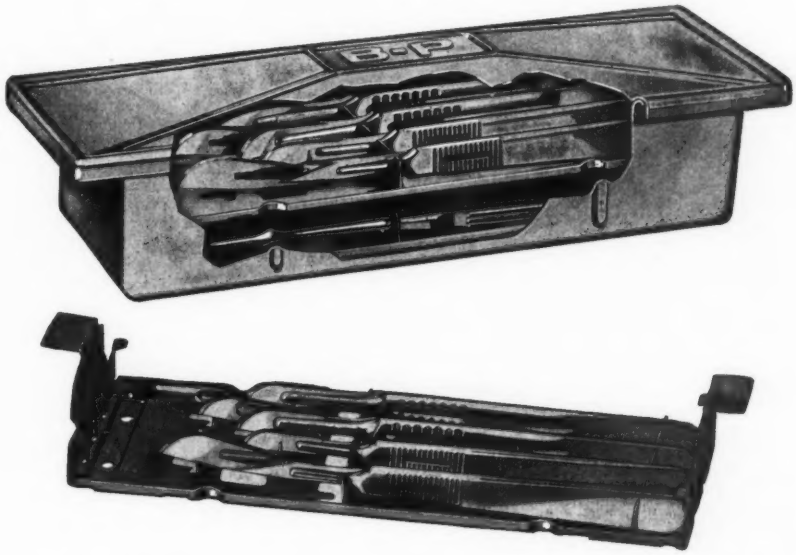
Big game fish have more surprising tricks than wild animals. You never know what they are going to do. Take the amberjack, a huge humped, amber-hued, hard-mouthed fellow weighing all the way up to 100 pounds. You never know whether he is going to come in easy, like a numbskull, or rush towards your boat like a flash and cut the line on the propeller.

If you are fishing from a wharf, he may head for the piles and snarl your line half a dozen times before he breaks it. I know a good sportsman in Florida

(Continued on page 34)

BOOK REVIEWS—Turn to page 34.
SOUTHERN MEDICAL NEWS—Turn to page 36.

INTRODUCING THE BARD-PARKER STERILIZING CONTAINER



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(Continued from page 416)

who saw a little group of big amberjacks and barracuda hanging like wolves on the edges of a school of mackerel. He cast his line near a huge amberjack. The water was very clear at about a depth of ten feet, and he could see the jack plainly from the wharf. An amberjack took hook, line and sinker, as the saying is, and he made the 60 to 80 feet to the wharf like a flash. Then the line went slack. The amberjack had cut it on the barnacles on the piers.

Soon after, the same fish was again seen in almost the same spot as before. Again the bait was cast and grabbed, but with the same result. The line was snarled and cut by the wily fish.

In the clear waters of the Florida keys you can often see myriads of fish. It is a tropical aquarium. The great game fish prey upon the smaller fry. Unlike half-domesticated game fish on reserves, the game fish of the semi-tropical seas never reach a stage of immunity that softens their fiber or vigor or diminishes their speed. Ceaselessly they prey and are preyed upon.

A sick or badly disabled fish undoubtedly is soon dispatched by other marauders of the deep. Fish seem to know when their victims are disabled. Even the swiftest fish are attacked by barracuda, sharks, porpoises and drag fish when they are on the line. Fish will attack wounded live bait on the line when they will not bother to pursue small fish of the same species.

Even making allowance for the individual equation in fighting qualities of fish of the same species, the sportsman is always sure of a battle royal with any of the principal great semi-tropical salt water game fish. The contest is the thing, and the tendency among amateur fishermen for some years has been toward constantly lighter tackle.

Book Reviews

Pneumonia. By Frederick Taylor Lord, A.B., M.D., Visiting Physician, Massachusetts General Hospital. 84 pages. Cambridge: Harvard University Press, 1929.

As a presentation of this subject for the layman, the manual is complete. It is unfortunate that the author takes such an optimistic attitude toward the treatment of pneumonia by Felton's antibody solution, because this work is still far from proven.

SOUTHERN MEDICAL NEWS—Turn to page 36.

WATAUGA SANITARIUM

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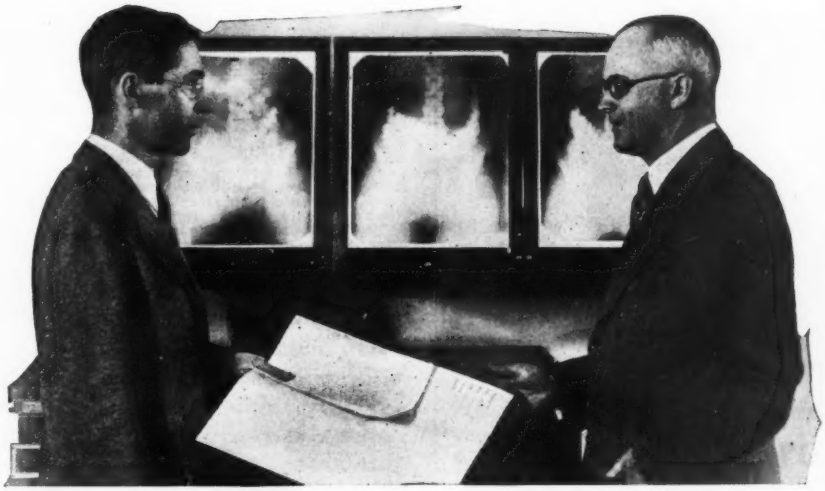

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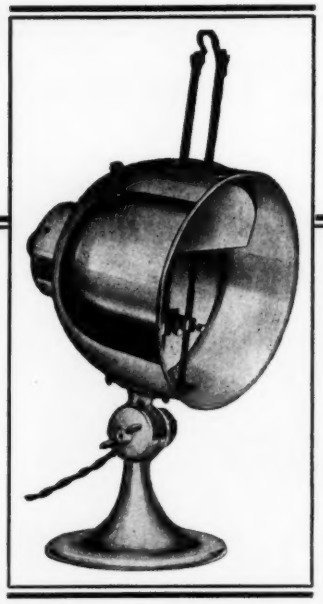

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Southern Medical News

DR. WILLIAM LeROY DUNN, VICE-PRESIDENT—IN MEMORIAM. A CORRECTION

A misstatement in the obituary of the late Dr. William LeRoy Dunn, of Asheville, Vice-President of the Association last year, which appeared in this column of the August (1928) issue of the JOURNAL, has been brought to our attention. It was stated that he came to Asheville because he had contracted pulmonary tuberculosis. A letter from Dr. C. D. W. Colby, of Asheville, Doctor Dunn's associate in practice, gives the following information: "Doctor Dunn never at any time in his life had tuberculosis, nor had any member of his staff. The owner of the Winyah Sanatorium in Asheville induced Dr. Arnold Klebs, some years ago, to come to this Country to have his anti-phthisin manufactured at the Winyah laboratory, but as neither Doctor von Ruck nor Doctor Klebs were laboratory men, it was necessary for them to get somebody to do this work. On account of Doctor Dunn's ability as a biological chemist, an offer was made him, while he was living in Illinois, of a salary which induced him to come to Asheville to make the anti-phthisin for Doctor von Ruck and Doctor Klebs. The anti-phthisin was a failure. However, Doctor Dunn continued in Asheville in his research work upon the chemistry of the tubercle bacillus."

The JOURNAL is glad to correct an error on this subject which may have done an injustice to the memory of a distinguished member of the Association or to his family.

AMERICAN COLLEGE OF PHYSICIANS' MEETING

The American College of Physicians will hold its Thirteenth Annual Clinical Session in Boston April 8-12. Dr. Charles F. Martin, Dean of the Faculty of Medicine, McGill University, is President of the College this year, and Dr. John H. Musser, Professor of Medicine at Tulane University Medical School, is President-elect and will be inducted to the Presidency toward the end of the Boston meeting. Programs and details concerning reduced fares, admission, etc., may be secured from the Executive Secretary, E. R. Loveland, 133-135 South Thirty-sixth Street, Philadelphia, Pennsylvania.

ALABAMA

Among the organizations to meet during the annual session of the Medical Association of the State of Alabama are: the Alabama State Association of Railroad Surgeons will meet on the evening of April 16; the Alabama Hospital Association on the evening of April 17; the eye, ear, nose and throat specialists on the evening of April 17 for their annual dinner and conference; the alumni of the Medical Department of the University of Alabama on April 17 at 8:00 p. m. for a banquet, followed by a public meeting. One of the features of the alumni banquet will be a memorial service in honor of the late Dr. Samuel W. Welch, Alabama's third health officer.

Fifteen additional Alabama counties were provided with full-time health units in 1928, making a total of 48 counties now organized.

Dr. John W. Wilson, Goodwater, has removed to Tuscaloosa to practice.

Forty Alabama towns, comprising 41 per cent of the population, come under the protection of the model milk ordinance drafted by the State Board of Health. Eighty per cent of the population is now protected through inspection of their milk supplies.

Dr. C. E. Laws, Fort Smith, Arkansas, appearing under the auspices of the Alabama Wild Life Conservation League, delivered an address in Birmingham on March 14 on the various phases of wild life conservation.

Dr. Estes H. Hargis, Birmingham, was married to Miss Florence Parker, Dallas, Texas, on December 22.

(Continued on page 38)

Tempt the convalescent's appetite with appealing tid-bits made from KNOX SPARKLING GELATINE

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Name..... Address.....

City..... State.....

(Continued from page 36)

Deaths

Dr. Archibald Wood Hatcher, Huntsville, aged 78, died January 8 of senility.

Dr. John Mortimer Naff, Talladega, aged 67, died January 5 of chronic nephritis.

ARKANSAS

The Arkansas Medical Society will hold its fifty-fourth session in Hot Springs May 7-8-9.

The Board of the Davis Hospital, Pine Bluff, at their meeting January 12 elected the following staff: Dr. C. K. Caruthers, Dr. Harry E. Williams, Dr. B. D. Luck, Dr. W. G. Pittman, Dr. Paul H. Power and Dr. A. A. Hughes.

The annual meeting of the Surgeons of the Missouri Pacific Lines of the Southern District was held in Little Rock January 14.

The Union County Medical Society has elected the following officers for this year: Dr. M. V. Russell, El Dorado, President; Dr. G. D. Murphy, El Dorado, Vice-President; Dr. Gordon Hastings, El Dorado, Secretary.

The Miller County Medical Society elected the following officers for 1929: Dr. J. T. Robison, Texarkana, President; Dr. W. P. Gardner, Texarkana, Vice-President; Dr. Herman Castile, Foreman, Secretary-Treasurer; Delegate to State Meeting, Dr. L. J. Kosminsky, Texarkana; Alternate, Dr. L. H. Lanier, Texarkana; Censor, Dr. H. E. Murry, Texarkana.

DISTRICT OF COLUMBIA

Deaths

Dr. Archie Ward Boswell, Washington, aged 57, died January 22.

Dr. Max Aaron Helfgott, Washington, aged 46, died February 3 of heart disease.

FLORIDA

The Orange County Medical Society has installed the following officers for 1929: Dr. J. H. Chiles, Orlando, President; Dr. W. H. Spiers, Orlando, Vice-President; Dr. J. R. Chappell, Orlando, Secretary; Dr. C. J. Collins, Orlando, Treasurer.

The Manatee County Medical Society elected the following officers for this year: Dr. L. W. Blake, Bradenton, President; Dr. M. M. Harrison, Palmetto, Vice-President; Dr. J. M. Davis, Bradenton, Secretary and Treasurer.

The Walton-Okaloosa County Medical Society elected the following officers for the ensuing year: Dr. E. L. Huggins, Freeport, President; Dr. J. C. McSween, DeFuniak Springs, Vice-President; Dr. A. G. Williams, Lakewood, Secretary-Treasurer.

The Marion County Medical Society has named the following as officers for this year: Dr. B. S. Stutts, Dunnellon, President; Dr. R. D. Ferguson, Ocala, Vice-President; Dr. Thomas H. Wallis, Ocala, Secretary-Treasurer.

Dr. R. E. Dicks, formerly of Dowling Park, has removed to Polk City.

Dr. W. S. Nichols has returned to Lake City from Athens, Georgia, to practice and will limit his work to eye, ear, nose and throat.

Dr. Walter A. Weed has accepted the Superintendency of the Morrell Memorial Hospital, Lakeland.

Dr. D. S. Fraser, formerly of Bonifay, has moved to Panama City.

Dr. G. C. Tillman, Gainesville, has been elected Chief of Staff of the Alachua County Hospital.

Dr. M. A. Lischkoff, Pensacola, has been elected President of the Kiwanis Club of that City.

Dr. William N. Parkinson, St. Augustine, has been appointed Medical Director of the Samaritan and Garretson Greatheart Hospitals of Temple University, Philadelphia, Penna.

Dr. J. C. Holley, Milton, and Miss Lucille Brown, Toccoa, Georgia, were married on November 28.

(Continued on page 40)

CONSTITUTIONAL INADEQUACIES

An Introduction to the Study of Abnormal Constitutions

By NICOLA PENDE, M.D., Professor of Clinical Medicine, Royal University of Genoa, Italy

Translated by SANTE NACCARATI, M.D., Sc.D., Ph.D., Associate Professor of Nervous and Mental Diseases, New York Post-Graduate Medical School

With a Foreword by GEORGE DRAPER, M.D.

Assistant Professor of Clinical Medicine, College of Physicians and Surgeons, Columbia University; Chief of Constitution Clinic, Presbyterian Hospital, New York City

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(Continued from page 38)

Dr. Walter Lawson Shackelford, West Palm Beach, and Miss Annette Laura Parker, Jacksonville, were married December 21.

Deaths

Dr. John C. Stephenson, Apopka, aged 65, died December 31.

Dr. Matthew R. Mitchell, Avon Park, aged 93, died December 27.

Dr. William Ezra Cole, Lake Mary, aged 86, died in December of senility.

Dr. Orin W. Sadler, Tarpon Springs, aged 85, died January 2 of arteriosclerosis.

GEORGIA

The State Board of Health held its annual meeting on January 30 and re-elected Hon. Robert F. Maddox, Atlanta, President; Dr. J. H. McDuffie, Columbus, Vice-President; and Dr. T. F. Abercrombie, Atlanta, Commissioner of Health.

The Atlanta Good Health Exposition, sponsored by the Junior Chamber of Commerce, will be held during the week of April 8.

Dr. Thos. J. Charlton, Savannah, was elected President of the Health Center at the recent meeting.

The Georgia Health Officers' Association, at its annual meeting in January, appointed a committee to redraft Georgia's public health laws along modern lines and to report at the annual session of the Medical Association of Georgia in May.

Dr. W. D. Travis, Covington, has been elected Health Officer for that City.

Dr. F. P. Harbin, formerly of Oconee, has moved to Tennille.

Dr. W. T. Tatum, formerly of Fort Gaines, has moved to Richland

Dr. James R. McCord and Dr. Dan C. Elkin, both of Atlanta, were awarded prizes by the Fulton County Medical Society (Atlanta) for the best papers read before the Society during the past year.

Dr. T. L. Holcombe, formerly of Union Point, has moved to Jefferson.

Dr. J. R. Anthony, Griffin, has been elected County Physician for Spalding County.

Dr. Wm. G. Lee, Macon, has been elected Chairman of the Board of Directors of the Macon National Bank.

Allen's Invalid Home, Milledgeville, has opened a new hospital building for women, with fifty private rooms and all modern equipment.

Dr. Wm. Funkhouser, Atlanta, has been appointed a member of the Georgia Children Code Commission.

Dr. Frank K. Boland, Atlanta, has been elected President of the Emory Alumni Association of Emory University.

Dr. John Walton is now Resident Physician at Blackman Health Resort, Atlanta, succeeding Dr. J. L. Pittman, Jr.

The Emory annual clinics will be held June 3-7.

St. Joseph's Infirmary, Atlanta, has elected the following officers on the Staff: Dr. George C. Mizell, President; Dr. H. R. Donaldson, Vice-President; and Dr. W. P. Nicholson, Secretary.

Major George S. Woodward, formerly of Walter Reed Hospital, Washington, has been assigned to duty as Medical Officer at Fort McPherson.

Dr. M. A. Rountree, after practicing medicine for thirty-five years at Adrian, has moved to Thomaston to practice.

Dr. William Salant has resigned as Head of the Department of Physiology and Pharmacology at the Medical Department of the University of Georgia, Augusta. He will devote his entire time to research at the Pharmacologic Section of the Biological Laboratory, Cold Spring Harbor, Long Island.

Dr. James R. McCord, Professor of Obstetrics and Gynecology, Emory University, Atlanta, will conduct a short course in obstetrics for the physicians in the Eleventh Congressional District during the week of April 8. This work is being done by arrangements with the State Health Department. Other courses will follow in the different districts of Georgia.

Under the supervision of the City Health Department of Atlanta the Public Health Nursing Department gave medical examinations to 50,442 children in 1928.

(Continued on page 42)

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(Continued from page 40)

Dr. Robert B. Ridley, Atlanta, and Mrs. Lillian Taylor Jones, Decatur, were married January 16.

Deaths

Dr. Frederick P. Nisbet, Atlanta, aged 64, died December 26.
Dr. William M. Painter, Dalton, aged 60, was killed December 19 when struck by a train.
Dr. George M. Barwick, Soperton, aged 62, died January 9 of influenza and pleurisy.
Dr. James L. Gable, Brooks, aged 68, died January 12 of pneumonia.
Dr. Simon Hull Smith, Culloden, aged 74, died December 13 of paralysis.
Dr. J. F. Findley, Cave Spring, aged 53, died January 8.
Dr. J. L. Brown, Camilla, aged 63, died January 30 from a heart attack.
Dr. John D. Goodwin, Kingston, aged 82, died January 12.

KENTUCKY

Dr. W. G. Gardner, Smithland, founder of the new Gardner Hospital, will be Superintendent and Chief Surgeon.
Dr. John V. Dillman, Louisville, and Mrs. Mary M. Lewis were married in December 1928.

Deaths

Dr. Isaac Thomas Houck, Louisville, aged 64, died January 28 of influenza.
Dr. Hugh Kimbley, Owensboro, aged 54, died January 3.
Dr. George S. McDonald, Irvine, aged 60, died in January of pneumonia.

LOUISIANA

The Lafayette Parish Medical Society elected the following officers for 1929: Dr. A. J. Comeax, Youngs-

(Continued on page 44)

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(Continued from page 42)

ville, President; Dr. L. A. Prejean, Scott, Vice-President; and Dr. W. J. Yongue, Lafayette, Secretary-Treasurer.

At the staff meeting of the North Louisiana Sanitarium, Shreveport, the following officers were elected: Dr. H. A. Durham, President; Dr. M. D. Hargrove, Vice-President; and Dr. C. H. Potts, Secretary.

At their annual meeting the Louisiana State Radiological Society elected the following officers for 1929: Dr. T. I. St. Martin, Houma, President; Dr. E. C. Samuels, New Orleans, Vice-President; and Dr. L. A. Fortier, New Orleans, Secretary.

The Presbyterian Hospital, New Orleans, celebrated its twenty-first birthday of continuous service January 23.

Deaths

Dr. Adolph O. Hoefeld, New Orleans, died on February 5.

Dr. James E. Pollock, New Orleans, aged 42, died suddenly February 18 of angina.

Dr. William D. Wall, Slaughter, aged 85, died January 16 of influenza.

Dr. James Marvin Cunningham, Castille, aged 51, died January 2.

Dr. William Davis Noble, Newellton, aged 38, died January 12 of pneumonia.

Dr. John Cecil Chapman, Colfax, aged 50, died January 22 of pneumonia.

Dr. J. B. Godfrey, Welsh, aged 73, died December 17.

MARYLAND

The Johns Hopkins University has received a gift of $3,000,000 from an anonymous donor for the maintenance of the medical and surgical clinics, and for the addition of 165 public beds, which amounts to the establishment of a new hospital. However, none of this money may be used for construction of buildings.

Dr. William H. Welsh, who was the orator at the Commemoration Day exercises of Johns Hopkins University, February 22, suggested, among other things, that the Chair of Medicine in Johns Hopkins be called the Osler Chair in memory of Sir William Osler, who was the first Professor of Medicine in the Medical School.

Dr. Emanuel Libman has given Johns Hopkins $10,000 to establish a lectureship in the history of medicine. It will be named the Hideyo Noguchi Lectureship.

The painting by Sargent, "The Four Doctors," is to be moved from the Johns Hopkins University to the new William H. Welch Medical Library in the hospital group. This picture portrays the late Sir William Osler, Dr. William S. Halsted, Dr. Howard A. Kelly and Dr. William H. Welch.

Dr. Joseph P. Franklin, formerly of Birmingham, Alabama, has been appointed Deputy State Health Officer for Allegany and Garrett Counties, and County Health Officer, with headquarters in Cumberland.

Deaths

Dr. John Mason Hundley, Baltimore, aged 70, died November 3.

Dr. Samuel A. Keene, Baltimore, aged 85, died February 4 of senility.

Dr. George W. Kennard, Baltimore, aged 73, died January 11 of heart disease.

Dr. William Clyde Burns, Baltimore, aged 60, died December 18.

Dr. Charles H. Bubert, Baltimore, aged 64, died January 31 of pneumonia.

Dr. Kent Cato Hammond, Dundalk, aged 27, died January 24 of pneumonia.

Dr. Clifton C. Laws, Chesapeake City, aged 55, died January 14.

MISSISSIPPI

The South Mississippi Medical Society has elected the following officers for 1929: Dr. R. H. Foster, Laurel, President; Dr. H. P. Smith, New Augusta,

(Continued on page 46)

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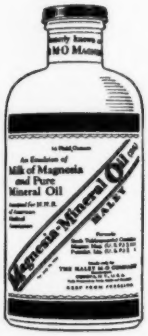

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(Continued from page 44)

First Vice-President; Dr. T. R. Beech, Ellisville, Second Vice-President; and Dr. J. H. Newcomb, Richton, Secretary-Treasurer.

Dr. W. L. Stallworth, Columbus, has been appointed City Health Officer to serve for the next two years.

The Madison County King's Daughters' Hospital, Canton, was formally opened to the public on January 22. The establishment of this Hospital was made possible by the activities of the Business and Professional Women's Club and the King's Daughters. It is a modern two-story brick structure.

Dr. W. W. Scott has moved to Jackson with offices in the Century Building.

Dr. J. R. Johnson has resigned as House Physician at the South Mississippi Charity Hospital, Laurel, to enter private practice.

Dr. R. J. Peterson, of Touro Infirmary in New Orleans, has been named as House Physician of the South Mississippi Charity Hospital at Laurel.

Dr. C. H. Love, former County Health Officer of Lamar County, has been transferred to Monroe County, Aberdeen, where he is Director of a newly organized full-time health department.

Dr. T. Paul Haney, Jr., has been transferred from the Tishomingo County Health Department, Iuka, to Holmes County.

Dr. J. W. Dugger, Jackson, was recently appointed Director of the Bureau of Industrial Hygiene of the State Board of Health.

Copiah County now has a full-time health unit with Dr. J. A. Milner as Director.

Dr. Mark Boyd, of the Rockefeller Foundation, has been assigned to the Mississippi State Board of Health, where he will have charge of the malarial control work.

Deaths

Dr. Harris Warren Crenshaw, Crenshaw, aged 73, died January 5, following an operation.

Dr. J. H. Cole, Tylertown, aged 92, died December 17.

Dr. Robert P. Crump, Nitta Yuma, aged 63, died January 19 of heart disease.

Dr. Harrison Prew Simpson, Beulah, aged 49, died January 27 from an accidental gunshot wound received while hunting.

Dr. Covington Hardy Sharp, Laurel, aged 39, died January 30 of pneumonia.

(Continued on page 48)

CLASSIFIED ADVERTISEMENTS

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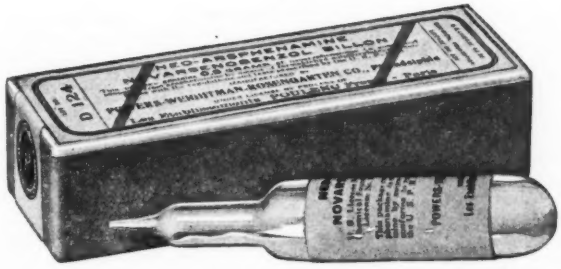

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(Continued from page 46)

Dr. J. B. Harris, Stewart, aged 67, died January 26 of cerebral hemorrhage.

Dr. Thomas F. Elkin, Tupelo, died January 30 from a prolonged illness.

MISSOURI

Dr. H. L. Kerr, Crane, has been elected President of the Missouri Board of Health; Dr. H. S. Grove, Linn, Vice-President; and Dr. James Stewart, Jefferson City, Secretary.

Dr. Maxwell Fineberg, St. Louis, has become associated with Dr. Max A. Goldstein in the practice of otolaryngology.

Dr. Joseph Erlanger, St. Louis, has been appointed a member of the National Committee on Development of the American Philosophical Society, under whose auspices an "intellectual stock taking" is to be made.

Ground has been broken for the new Deaconess Hospital, St. Louis, which is to be seven stories high, with a 218-bed capacity, and will cost more than $1,000,000.

Dr. James Moores Ball, St. Louis, has presented the St. Louis Medical Society with a rare collection of about 800 medical books. The collection is valued at $10,000 and includes many texts printed in the Fifteenth and Sixteenth Centuries.

The Jewish Hospital, St. Louis, has received a gift of $150,000 from Mr. and Mrs. Mark C. Steinberg for the construction of a building for the care of chronic invalids, which is to be a memorial to Mrs. Steinberg's father.

Deaths

Dr. Arthur Eugene Ewing, St. Louis, aged 73, died January 26 of cerebral hemorrhage.

Dr. H. S. Maxwell, Hopkins, died January 5.

Dr. Horne Miles, Webster Grove, aged 64, died January 17 of enteritis.

Dr. Gracey Waddell, Bertrand, aged 70, died January 12 of pneumonia.

Dr. J. N. Devillo, Pottersville, aged 81, died January 11 of influenza.

Dr. Cyrus C. Kerlagon, Bismarck, aged 73, died January 30 of appendicitis.

Dr. Hiram McElroy Dagg, North Kansas City, aged 78, died January 26 of pneumonia.

Dr. Thomas Buford M. Craig, Nevada, aged 58, died January 24 of heart disease.

Dr. Robert Scott Magee, Green City, aged 74, died January 8 of pneumonia.

Dr. George Clark Mosher, Kansas City, aged 70, died January 18 of acute myelogenous leukemia.

Dr. Harvey G. May, Harrisonville, aged 64, died suddenly January 18 of heart disease.

Dr. Albert J. Henderson, Kansas City, aged 56, died January 3 of carcinoma of the esophagus.

Dr. Samuel Sheldon, Trenton, aged 55, died suddenly December 11 of heart disease.

NORTH CAROLINA

Two eminent physicians of Southern birth and training will fill the Chairs of Surgery and Pathology, respectfully, at Duke University beginning in 1930. Dr. Julian Deryl Hart, now of Baltimore, will be Professor of Surgery. Dr. Hart was born in Georgia, was graduated from Emory University and the Johns Hopkins Medical School, and has been a member of the Department of Surgery of the Johns Hopkins Medical School and Hospital for the past eight years. Dr. Wiley Davis Forbus has been ap-

(Continued on page 50)

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(Continued from page 48)

pointed Professor of Pathology. Dr. Forbus was born in Mississippi, received his academic training at Washington and Lee and his M.D. at the Johns Hopkins. He has been a member of the Department of Pathology of the Johns Hopkins Medical School and Hospital for the past six years.

Rutherford County Medical Society has elected Dr. P. H. Wiseman, Avondale, President; Dr. C. F. Glenn, Rutherford, Vice-President; and Dr. W. C. Bostic, Sr., Forest City, reelected Secretary-Treasurer.

Dr. William deB. MacNider, Chapel Hill, was invited to deliver one of the series of Harvey Lectures which was held at the Academy of Medicine in New York in January.

The Highsmith Hospital, Fayetteville, the oldest private hospital in the State, has identified itself with the Duke Endowment and has reorganized on a non-profit basis. It will receive from the Duke Foundation one-third of the cost for all charity patients.

Work will be started immediately on a new baby hospital at Roaring Gap and probably will be ready for use by June. The hospital is a gift from Mrs. James Gray, of Winston-Salem. Dr. L. J. Butler, of Winston-Salem, will be in charge.

Dr. Herbert Gorham, Winston-Salem, has been elected County Health Officer for Surry County.

Dr. Joseph Treolar Wearn, formerly of Charlotte, has been chosen Head of the Department of Medicine of the School of Medicine, Western Reserve University, Cleveland, Ohio.

Dr. C. M. Lentz, Albemarle, has been reelected County Physician.

The North Carolina State Hospital Association will meet at High Point May 14-15-16.

Dr. George C. Andes has opened his office with Dr. L. D. McPhail, Professional Building, Charlotte.

Dr. S. A. Nathan, Chapel Hill, has been appointed Quarantine Officer for Orange County.

Dr. Harry B. Ditmore and Miss Pauline Ramsey, both of Marshall, were married December 20.

(Continued on page 52)

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(Continued from page 50)

Dr. Henry F. Hunt, of the Mayo Clinic, Rochester, has been granted a leave of absence to teach in the Department of Pathology at the University of North Carolina.

Dr. Grady A. Morgan, Asheville, has been reelected Health Officer of Buncombe County.

Deaths

Dr. Thomas R. Harding, Yadkinville, aged 73, died February 6 of cerebral hemorrhage.

Dr. P. J. Klutz, Maiden, died in January.

Dr. Robert Vance Brawley, Salisbury, aged 50, died January 5 of pneumonia.

Dr. James Henry Anderson, Tarboro, aged 80, died January 17 of heart disease.

OKLAHOMA

The Oklahoma State Medical Association will meet in Oklahoma City May 27-28-29 for its annual session.

Dr. O. J. Gee, formerly of Ardmore, has moved to Oklahoma City.

Dr. P. F. Robinson, Madill, has been appointed Health Officer for Marshall County.

Dr. F. R. Sutton, Oklahoma City, has given the Library of the School of Medicine 140 volumes, mostly on surgery.

The new Baptist Hospital, Muskogee, was formally opened on February 3.

The Hughes-Seminole Medical Society elected the following officers for 1929: Dr. A. L. Davenport, Holdenville, President; Dr. W. M. Taylor, Vice-President; and Dr. T. H. Diggs, Secretary-Treasurer.

The Oklahoma Skin and Cancer Clinic, Oklahoma City, has been organized with offices in the Medical Arts Building with Dr. E. S. Lain, Dr. M. M. Roland, Dr. W. E. Eastland, Dr. Chas. E. Davis and Dr. D. G. Duncan as members.

(Continued on page 54)

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(Continued from page 52)

Deaths

Dr. John O. Grubbs, North McAlester, aged 66, died January 16 of pneumonia.

Dr. Jason Emmett Billington, Enterprise, aged 58, died January 12 of myocarditis.

Dr. Walter W. Van Noy, Kiefer, aged 75, died January 15 of influenza.

Dr. John W. Rollins, Atoka, aged 66, died January 4 of pneumonia.

Dr. John Kent Kindsey, Elmore City, aged 60, died January 15 of pneumonia.

SOUTH CAROLINA

Dr. C. N. Wyatt, formerly of Greenville, has become associated with Dr. R. E. Hughes, of Laurens.

Dr. Noble Dick, formerly of Sumter, is now associated with the Mason Clinic, Seattle, Washington.

Dr. William A. Woodruff has been appointed a Trustee of the Medical College of the State of South Carolina, Charleston.

Deaths

Dr. W. A. Wallace, Spartanburg, aged 47, died January 31.

Dr. James Franklin Baker, Graniteville, aged 69, died January 10.

Dr. Percy Herbert Birgham, Florence, aged 55, died January 9 of heart disease.

Dr. William B. Way, Ridgeville, aged 73, died December 29 of influenza.

TENNESSEE

Dr. Ernest W. Goodpasture, Professor of Pathology at the Vanderbilt University School of Medicine, Nashville, delivered one of the De Lamar Lectures in Hygiene at the Johns Hopkins School of Hygiene

(Continued on page 56)

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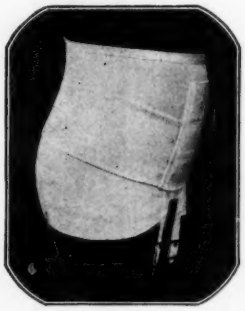

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(Continued from page 54)

and Public Health, Baltimore, on February 26, his title being "Herpetic Infection, with Especial Reference to Involvement of the Nervous System."

Dr. Frank Faulkner and Dr. Charles Armstrong, former internes at the Knoxville General Hospital, have opened offices in Knoxville for general practice.

Dr. Victor H. Bean, Knoxville, has been appointed Medical Director of Beverley Hills Sanatorium.

The Knoxville General Hospital opened its new contagious unit on January 12.

Dr. M. F. Haygood, Nashville, has been elected Secretary of the Southern Tuberculosis Conference.

Dr. J. E. Mathis, Eastland, has been appointed Assistant Physician at the Eastern State Hospital.

Meharry Medical College, Nashville, has received $2,000,000 from the General Education Board of New York and the Julius Rosenwald Fund of Chicago for a new school for training negro students in medicine, dentistry and pharmacy. The College has also received $200,000 from the alumni to provide a 120-bed hospital. This College was established in Nashville fifty-two years ago.

Dr. M. L. Patton, Memphis, has moved his offices to the Medical Arts Building.

Davidson County Medical Society has elected the following officers for 1929: Dr. J. O. Manier, Nashville, President; Dr. T. G. Pollard, Nashville, Vice-President; and Dr. Sam P. Bailey, Nashville, Secretary.

Giles County Medical Society elected the following officers: Dr. A. M. Allen, Pulaski, President; Dr. W. J. Johnson, Pulaski, Secretary; and Dr. G. D. Butler, Pulaski, Treasurer.

Madison County Medical Society has elected the following officers: Dr. J. R. Thompson, Jackson, President; Dr. Sam T. Parker, Jackson, Vice-President; Dr. B. C. Arnold, Jackson, Secretary-Treasurer.

Deaths

Dr. George Lacy, Medon, aged 83, died December 24.

(Continued on page 58)

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NEW ORLEANS, LA.

(Continued from page 56)

Dr. Merritt B. Smiser, Culleoka, aged 80, died January 20 of pneumonia.

Dr. Wade Hampton Bolton, Memphis, aged 65, died December 19 of cerebral hemorrhage.

Dr. Joseph T. Freeman, Paris, aged 52, died suddenly January 25.

Dr. William K. Vance, Bristol, aged 77, died December 29.

Dr. Luther Lynnville Alexander, Paris, aged 77, died January 17 of pneumonia.

Dr. J. W. MacQuillan, Chattanooga, aged 72, died January 23.

TEXAS

San Antonio is to have a new medical building to cost about $830,000. It will be fourteen stories and the upper seven floors will be used as a general hospital, the other floors to be used for offices.

The Mineral Wells Clinic has been reorganized with Dr. J. H. McCracken, Sr., as Medical Director and head of the Department of Diagnosis and Internal Medicine; Dr. J. H. McCracken, Jr., head of the Department of Surgery and Gynecology; and Dr. Edwin F. Yeager, head of the Department of Urology and Dermatology.

To care for the large number of influenza cases in Collingsworth County, the county and city officials of Wellington established a City-County temporary hospital. It was immediately filled with patients. While the hospital is only a temporary arrangement, it may result in the establishment of a permanent City-County Hospital.

The New Austin City Hospital was formally opened on January 6.

Dr. Arb C. DeLong, San Angelo, has resigned as Health Officer after serving five years.

Dr. Melvin C. Mars, Sulphur Springs, has been appointed Health Officer of Hopkins County.

Dr. Scott E. McNeill, Beeville, has been elected Health Officer of Bee County.

(Continued on page 60)

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HORLICK'S

(Continued from page 58)

Deaths

Dr. Frank Douglas Boyd, Fort Worth, aged 61, died January 4 of a heart attack.

Dr. Garland Ben Foscue, Waco, aged 68, died December 3.

Dr. John Stephen Zvesper, Schulenburg, aged 58, died January 20 of cerebral hemorrhage.

Dr. George Norman Lucas, Brownsville, aged 68, died January 25 of heart disease.

Dr. Doyle Lee Eastland, Waco, aged 45, died January 11 of lobar pneumonia.

Dr. Oscar Ernst Blank, Perryton, aged 36, died in January.

Dr. Winston James Davie, Wrightsboro, aged 68, died December 5 of influenza.

Dr. Charles Edward Schenck, Sherman, aged 58, died January 2 of paralysis.

Dr. Marvin Luther Turney, Alpine, aged 42, died January 13 of heart disease.

Dr. Joseph Frank Flinn, Hutto, aged 70, died January 17.

Dr. Thomas Benton Morgan, Bronson, aged 59, died December 13 of heart disease.

Dr. George Whitfield Hutchinson, Ebony, aged 67, died December 18 of heart failure.

Dr. W. D. Gilstrap, Wheelock, aged 62, died December 14.

VIRGINIA

Memorial Hospital and Edmunds Hospital, Danville, have been merged.

Dr. W. F. Drewry, Petersburg, has been named Director of the newly created Bureau of Mental Hygiene, which is a part of the State Department of Public Welfare.

Dr. Frank S. Johns, Richmond, has become Chief Surgeon of Johnston-Willis Hospital, following the death of Dr. Murat Willis.

Dr. George W. Black has removed from Pineville to Charlotte.

The Petersburg Hospital, Petersburg, has chosen the following officers for this year: Dr. Mason Romaine, Chairman; Dr. George H. Reese, Vice-Chairman; Dr. C. W. Lynn, Secretary; and Dr. Philip Jacobson, Vice-Secretary.

Dr. J. Bolling Vaiden has moved from Highland Springs to Lawrenceville.

The Virginia Tuberculosis Association held its annual meeting in Richmond on February 28.

Dr. Joseph T. McKinney, Roanoke, has been elected President of the Kiwanis Club for this year.

Dr. Thomas P. Haslam, formerly Associate in the Department of Pathology, Medical College of Virginia, has been appointed Director of the Baylor Out-Patient Clinic at Dallas, Texas.

Deaths

Dr. Walter W. Johnson, Covington, aged 53, died December 12 of cerebral hemorrhage.

Dr. T. Edwin Baird, Norfolk, aged 63, died January 6 following a long illness of asthmatic attacks.

Dr. Robert H. Latane, Buchanan, died January 12.

Dr. Edward Thomas Mason, Savageville, aged 58, died December 5.

(Continued on page 62)

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(Continued from page 60)

WEST VIRGINIA

The Marion County Medical Society has elected the following officers: Dr. H. S. Keister, Fairmont, President; Dr. J. J. Jenkins, Farmington, Vice-President; Dr. Philip Johnson, Secretary; and Dr. C. W. Waddell, Fairmont, Treasurer.

The Logan County Medical Society elected the following officers for 1929: Dr. C. A. Martin, Amherstdale, President; Dr. T. J. Ferrell, Chapmanville, Vice-President; and Dr. P. B. Wingfield, Logan, re-elected Secretary-Treasurer.

The Mercer County Medical Society has elected the following officers: Dr. B. S. Clements, Matoaka, President; Dr. C. J. Reynolds, Bluefield, Vice-President; Dr. H. G. Steele, Bluefield, Secretary; and Dr. C. T. St. Clair, Bluefield, Treasurer.

President Edwin A. Alderman, University of Virginia, will deliver the principal address at the ninety-first commencement of the Medical College of Virginia, Richmond, on May 28.

Dr. John W. Stephenson, Ashland, has purchased the Baptist General Hospital of that City and has renamed it the Stephenson Hospital and Clinic.

Alma C. Corbitt, R. N., has been appointed Superintendent of the Charleston General Hospital, Charleston.

Deaths

Dr. John W. Rickey, Moundsville, aged 86, died January 24 of senility.

Dr. John L. Dickey, Wheeling, aged 74, died February 5 of myocarditis.

Dr. Charles Quincy Nelson, Morgantown, aged 73 died December 26 of injuries received when struck by an automobile.

Dr. A. J. Evans, McMechan, aged 70, died January 13 of cerebral hemorrhage.

Dr. Robert E. Vickers, Huntington, aged 72, died February 27.

Dr. James Henry Thornbury, Crites, aged 74, died December 12 of pneumonia.

Dr. Edward Stanard Buffington, Huntington, aged 81, died February 24 of heart failure.

Dr. Steven Douglas Few, Parsons, aged 69, died January 23 of double pneumonia.

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